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549

DIGITAL UNIVERSAL METER TYPE A1613

SOLARTRON

TECHNICAL MANUAL

MP MASTER
MA24232

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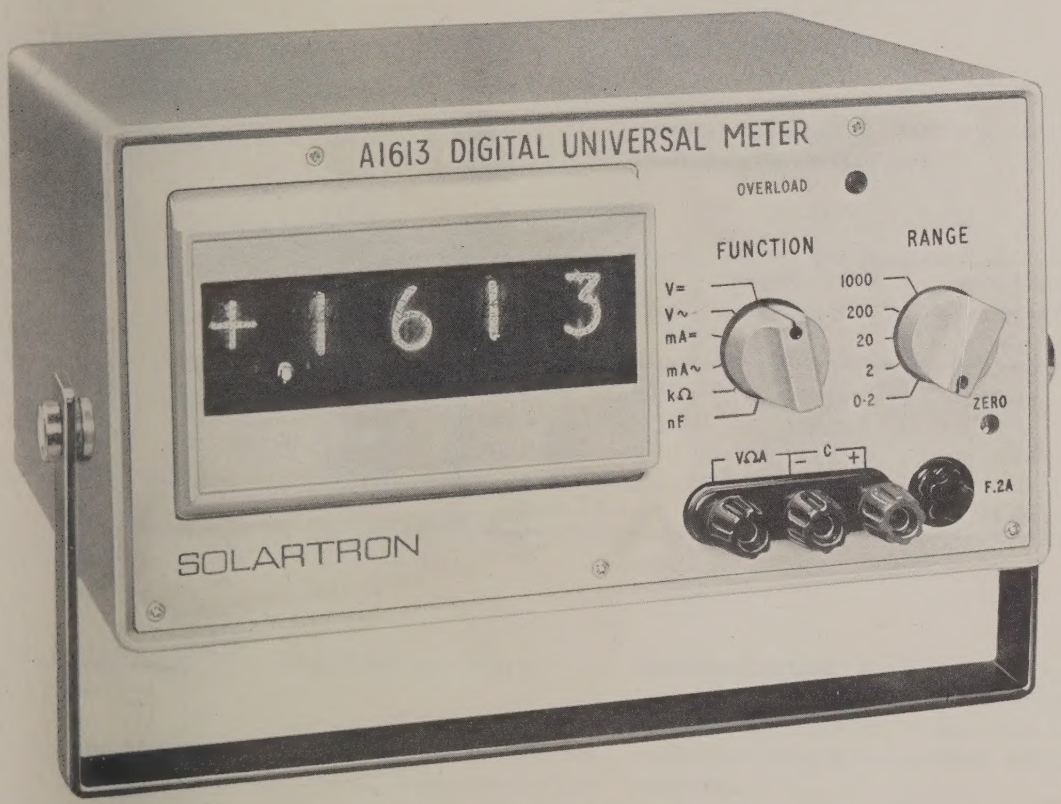
DIGITAL UNIVERSAL METER TYPE A1613



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SECTION 1
GENERAL

Purpose of the Instrument
The Digital Universal Meter type A.1613 has the characteristics of a conventional Universal Meter, and the advantages of Digital equipment: high accuracy, high definition, high reliability, ease and speed of reading etc.

The instrument measures:
Direct and alternating voltages
Direct and alternating currents
Resistance
Capacitance

Detailed Specification
The Digital Universal Meter Type A.1613 measures six parameters as selected by the switch S1201:
DC Voltage (V =)
AC Voltage (V~)
Direct Current (mA =)
Alternating Current (mA~)
Resistance (KΩ)
Capacity (nF)

The front panel is engraved to indicate parameter and range of measurement. Small neon lamps indicate the position of the decimal point.

DC Voltage

Range	Resolution	Accuracy ($25^{o}C \pm 5^{o}C$)	Common Mode Rejection at DC	Common Mode Rejection (AC up to 5kHz)
200 mV	100 μV	0.1% ± 1 digit	130 dB	120 dB
2 V	1 mV	0.1% ± 1 digit	110 dB	100 dB
20 V	10 mV	0.1% ± 1 digit	90 dB	80 dB
200 V	100 mV	0.1% ± 1 digit	70 dB	60 dB
1000 V	1 V	0.1% ± 1 digit	50 dB	40 dB

Input Impedance: 100 kΩ/Volt with a maximum of 2 MΩ.

Response Time: Approximately 1 second to reach 99.9% of the absolute value, for a voltage change equal to full scale of range in use.

Polarity Indication: Automatic by neon indicator.

Input Isolation: Resistance to earth from the input terminals is greater than 1000 MΩ, and the insulation will withstand 500 Volts DC.

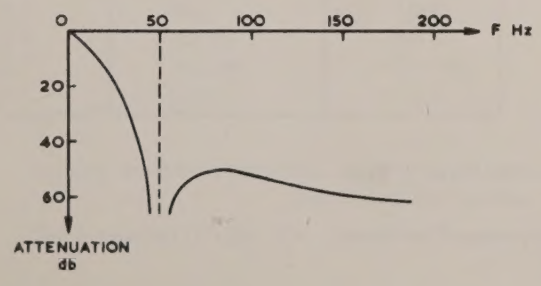
Temperature Coefficient: Approximately 0.01%/$1^{o}C$ between $10^{o}C$ and $40^{o}C$.

Mains Variations: Variations in supply voltage between -10% and +10% of the selected value do not reduce measurement accuracy.

Humidity: Relative Humidity up to 70% does not reduce measurement accuracy.

Maximum Overload: The equipment is not damaged by overloads of 100 times the full scale of the range in use, up to a maximum of 1000 Volts. A small indicator lamp on the front panel of the instrument indicates an overload condition.

Series Mode Rejection (AC): Greater than 60dB at 50Hz.



AC Voltmeter

Range	Resolution	Accuracy and Bandwidth ($25^{o}C \pm 5^{o}C$)	Common Mode Rejection at DC.	Common Mode Rejection (AC).
200 mV	100 μV	50Hz to 5kHz. 0.2% ± 1 digit. 40Hz to 20kHz. 0.5% ± 1 digit.	130 dB	120 dB
2 V	1 mV	50Hz to 5kHz. 0.2% ± 1 digit. 40Hz to 10kHz. 0.5% ± 1 digit.	110 dB	100 dB
20 V	10 mV	50Hz to 5kHz. 0.2% ± 1 digit. 40Hz to 10kHz. 0.5% ± 1 digit.	90 dB	80 dB
200 V	100 mV	50Hz to 5kHz. 0.2% ± 1 digit. 40Hz to 10kHz. 0.5% ± 1 digit.	70 dB	60 dB
750 V	1 V	50Hz to 5kHz. 0.2% ± 1 digit. 40Hz to 10kHz. 0.5% ± 1 digit.	50 dB	40 dB

Input Impedance: 100 kΩ/Volt with a maximum of 2 MΩ, in parallel with approximately 30pF.

Response Time: Approximately 2 seconds to reach 99.8% of the absolute value, for a change of voltage at the input equal to the full scale of the range in use.

Isolation: The voltage between the input terminals and earth must not exceed 500 Volts.

Superimposed DC: A DC voltage of up to 60 Volts can be superimposed on the AC signal being measured, on any range, without reducing the accuracy.

Temperature Coefficient: 0.02%/^{o}C between 0 and 45^{o}C.

Mains Variations: Variations in mains voltage between -10% to +10% of the selected value do not reduce measurement accuracy.

Humidity: Relative humidity up to 70% does not reduce measurement accuracy.

Effect of Signal Distortion: The instrument measures mean value, and is scaled in RMS value for a sine wave. In the case of a non-sinusoidal signal, the error is approximately 1% for a distortion of 3% of the input signal.

Maximum Overload: The instrument is not damaged by overloads of 100 times the full scale of the range in use, up to a maximum of 750 Volts. A small neon lamp on the front panel indicates an overload condition.

DC Ammeter

Range	Resolution	Accuracy ($25^{o}C \pm 5^{o}C$)	Series Mode Rejection at 50Hz.	Maximum Overload
200 μA	100 nA	± 0.2%	>60 dB	2 A
2 mA	1 μA	± 0.2%	>60 dB	2 A
20 mA	10 μA	± 0.2%	>60 dB	2 A
200 mA	100 μA	± 0.2%	>60 dB	2 A
1 A	1 mA	± 0.2%	>60 dB	2 A

Common Mode Voltage: 500 Volts maximum between the input terminals and earth.

Temperature Coefficient: <0.02%/^{o}C between 0 and 45^{o}C.

Voltage Drop Across Input Terminals: Approximately 100 mV for full scale current on each range.

Overload Protection: Current overload protection is provided by a front panel mounted 2 amp fuse. A spare fuse is fixed to the chassis just inside the rear panel.

Polarity Indication: A neon lamp automatically displays the correct polarity.

PLEASE NOTE

This instrument can withstand 100 times F.S. overload on voltage ranges, but the selection of current, resistance or capacitance ranges when a low impedance voltage source is connected to the input is likely to cause damage. This damage is not likely to be severe or, therefore, very expensive to repair, but it obviously cannot be covered under the guarantee.

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COMPONENT PARTS LISTS

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COMPONENT LOCATION DIAGRAMS

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AC Ammeter

Range	Resolution	Accuracy and Bandwidth ($25^{o}C \pm 5^{o}C$)	Maximum Overload
200 μA	100 nA	50 Hz to 1kHz. 0.3% ± 1 Digit. 40 Hz to 10kHz. 0.5% ± 1 Digit.	2A
2 mA	1 μA	50 Hz to 1kHz. 0.3% ± 1 Digit. 40 Hz to 10kHz. 0.5% ± 1 Digit.	2A
20 mA	10 μA	50 Hz to 1kHz. 0.3% ± 1 Digit. 40 Hz to 10kHz. 0.5% ± 1 Digit.	2A
200 mA	100 μA	50 Hz to 1kHz. 0.3% ± 1 Digit. 40 Hz to 10kHz. 0.5% ± 1 Digit.	2A
1 A	1 mA	50 Hz to 1kHz. 0.3% ± 1 Digit. 40 Hz to 10kHz. 0.5% ± 1 Digit.	2A

Voltage Drop Across the Input Terminals: Approximately 100 mV RMS for full scale current.

Effect of Signal Distortion: The instrument measures mean value and is scaled in RMS for a sine wave. In the case of a non-sinusoidal input, the error is approximately 1% for a distortion of 3% of the input signal.

DC Common Mode: Maximum DC voltage to earth from the terminals is 500.

AC Common Mode: The maximum AC voltage to earth from the terminals is 200 Volts RMS.

Superimposed DC Current: Superimposed direct currents do not reduce measurement accuracy of the instrument when working on the AC current ranges, providing their value does not exceed 5% of full scale for the range in use.

Temperature Coefficient: Less than 0.03%/^{o}C between 0 and 45^{o}C.

Ohmmeter

Range	Resolution	Accuracy ($25^{o}C \pm 5^{o}C$)	Measurement Current (± 10%)	Response Time Secs.
200 Ω	0.1 Ω	0.25% ± 1 digit.	10 mA	<1.5
2 KΩ	1 Ω	0.25% ± 1 digit.	1 mA	<1.5
20 KΩ	10 Ω	0.25% ± 1 digit.	100 μA	<1.5
200 KΩ	100 Ω	0.25% ± 1 digit.	10 μA	<3
1 MΩ	1kΩ	0.25% ± 1 digit.	1 μA	<10

Measurements up to 2MΩ can be made on the 1MΩ range with an accuracy of ±0.3%.

Temperature Coefficient: <0.025%/^{o}C between 0 and 45^{o}C.

Overload Protection: No damage is caused to the instrument, on any range, whatever value of resistance, between zero and infinity, is connected between the terminals. The overload warning light indicates if the value of resistance connected is outside the range selected.

Up to 30 Volts can be applied to the terminals for short periods, on any resistance range, without damage to the instrument.

Capacitance Meter

Range	Resolution	Accuracy ($25^{o}C \pm 5^{o}C$)	Measuring Frequency ($\pm$ 20%)	Response Time Secs.
200 pF	0.1 pF	$\pm$ 0.3% $\pm$ 0.3 pF	150kHz	2
2 nF	1 pF	$\pm$ 0.3% $\pm$ 1 digit.	26kHz	2
20 nF	10 pF	$\pm$ 0.3% $\pm$ 1 digit.	3kHz	2
200 nF	100 pF	$\pm$ 0.3% $\pm$ 1 digit.	300Hz	2
1 μF	1 nF	$\pm$ 0.3% $\pm$ 1 digit.	30Hz	2

DC Voltage: Approximately 4 Volts is applied to the capacitor being measured. The polarity of this voltage is indicated on the input terminals.

Leakage Resistance: Accurate measurements are possible only on capacitors with a leakage resistance of >5 MΩ. If the leakage resistance of the capacitor is 1 MΩ, the lower 1% of the range in use is invalid.

Temperature Coefficient: <0.025%/^{o}C between 0 and 45^{o}C.

Overload Protection: No damage is caused to the instrument on any range by the connection of any capacitance between zero and infinity to the input terminals. The overload lamp indicates when the value of capacitance at the input is outside the range selected.

Up to 5V can be applied for short periods to the input terminals on any capacitance range without damage to the instrument.

When any other function is selected the special capacitance measuring terminal is disconnected.

Modes of Operation

Automatic Mode

When the mode switch S1402 is in the 'auto' position, measurements are repeated at approximately 3 second intervals.

Remote Operation

When the mode switch S1402 is in the remote position, measurement is initiated by contact closure across the terminals J1402 and J1403 on the rear panel of the instrument. The minimum time interval between two measurements in 200mS.

Print-Out Information (Figure 1.1)

When the instrument is fitted with an output socket (A1613T) the following output information is available from the back of the instrument:

Print Command

Positive pulse from -8 Volts to 0 Volts from a source impedance of approximately 2.5kΩ, lasting from the end of one measurement to the start of the next measurement.

Measured Value

Code 1 - 2 - 4 - 8 BCD: '0' = 0 to -0.5 Volts.
'1' = 9 Volts $\pm$ 20% 17kΩ source resistance.

No damage or degradation in accuracy is caused by earthing the print-out connections.

Polarity

Polarity of DC measurement is available:
$-V_e$ = -12 Volts,
$+V_e$ = 0 Volts.
18kΩ source resistance on pin 18 of the output socket J1405.

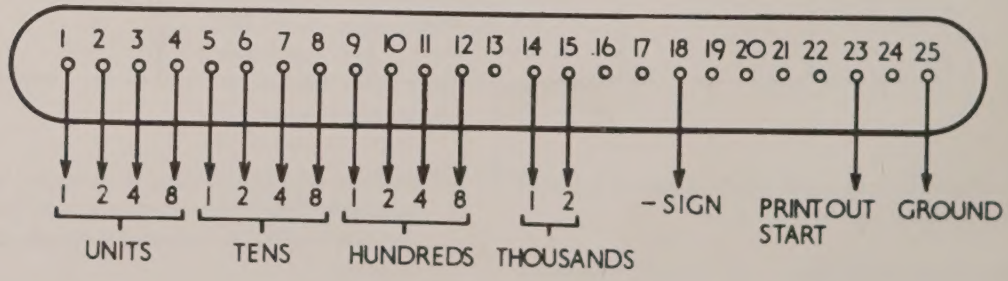


Fig. 1.1

Note: The automatic mode of operation of the type 1613 can only be used with printers capable of a speed of at least 3 readings per second. For slower printers the remote mode of operation must be used, the measurement and print-out cycle being initiated by contact closure from a button or timer having totally isolated contacts.

It is also possible to arrange successive measurement and print-out re-cycling at a maximum possible speed with any printer, by using the print complete contact on the printer to initiate the next measurement. The 'print complete' contact closure is connected to the remote command contacts on the rear of the 1613 and the instrument used with the mode switch switched to remote.

Power Supply

Input voltage tappings of 115, 127, 220, 240 V RMS.
Each tapping will accommodate $\pm$ 10% variations.
Supply frequency 48 - 450 Hz.
Consumption: approximately 20VA.

Mechanical Characteristics

Dimensions: Height 5.1", Width 9.5", Depth 8.25"
Weight: approximately 7 lbs.

SECTION 2

OPERATION

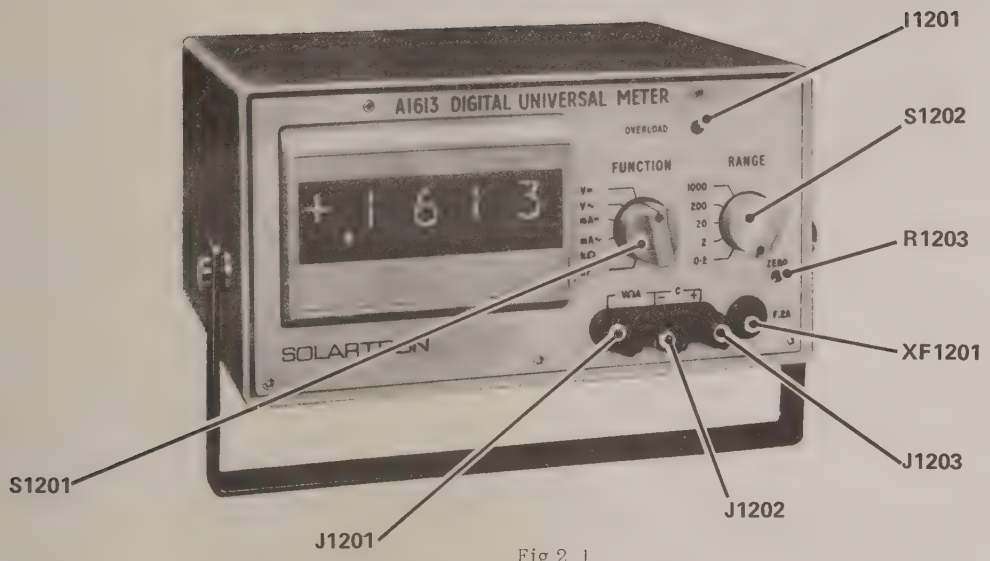


Fig 2.1

Description

The instrument is normally supplied in a portable cabinet, with a carrying handle attached. This handle also raises the front of the instrument for bench use.

Front Panel (Fig.2.1)

The following controls etc., are mounted on the front panel:
The main function switch S1201
The main range switch S1202
Zero control R1203
Fuse holder for the protection of the instrument when used as an ammeter XF1201
Overload indicator lamp I1201
Terminal for input low connection (black) J1201
Terminal for input high connection (red) J1202
Terminal for capacitance meter input (green) J1203
Four number tubes for the display of reading
One display tube for polarity
Four neons indicating position of the decimal point
I1 I2 I3 I4.

Rear Panel (Fig.2.2)

The rear panel carries the following:
Power Supply socket J1401
Mains on/off switch S1401
Mains adjustment panel for 115, 127, 220, 240 volts, together with mains fuse (S1403 XF1401)
Mode of operation switch S1402 (Auto or remote command)
Two 4mm sockets for connection of the remote command information J1402 and J1403.
Socket for instrument earth connection J1404
Print out socket for connection of the BCD output information to a Printer, or any other interface (optional).

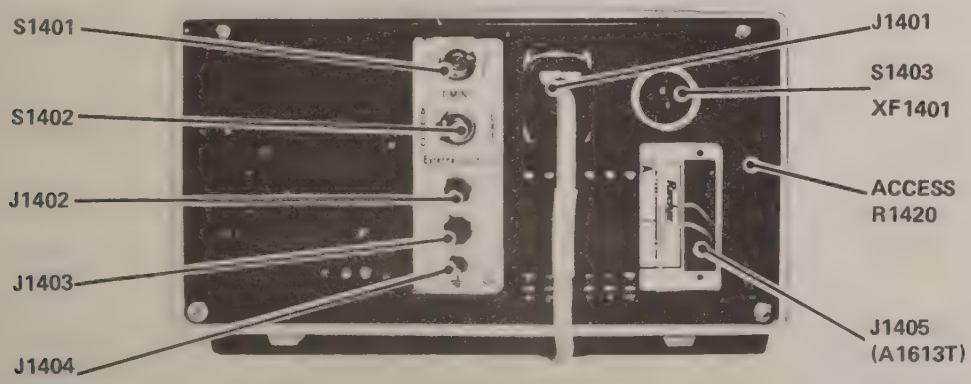


Fig 2.2

Operation

To Operate the Instrument

Adjust the mains selector situated at the rear of the instrument, to the nearest value for the mains supply. Note: An incorrect setting (e.g. the connection of 220 volts when the adjustor is set to the 115 position) will damage the power supply diodes, filter capacitors and a number of semi-conductors.

Connect the instrument to the power supply socket and switch on by means of the mains switch S1401 on the rear panel. The display number tubes should immediately light up.

Select the mode of operation required by the switch on the rear panel. Select the appropriate function and range of measurement using the switches S1201 and S1202 on the front panel.

The instrument can be used immediately after switch on, but maximum accuracy and stability will be obtained by allowing a 30 minute warm-up.

The instrument chassis is normally connected to earth by the green wire in the power supply cable. If the instrument is connected to a power supply having no earth connection, it is possible to provide an earth connection by means of the socket J1404 on the rear panel of the instrument.

Adjustment of Zero Control

For correct adjustment of the zero control, turn the function switch to DC volts, and open circuit the input connections. Adjust the zero potentiometer until a steady zero reading is obtained on the display.

Principle of Operation

The A. 1613 Digital Universal Meter operates on the principle of voltage to time conversion, the time then being measured by a digital electronic counter.

The various input functions and ranges are all converted, by the input circuitry, into a voltage of 0 - 2 Volts for full scale reading. This voltage is then converted into time by comparison with a waveform of voltage rising linearly with time (linear sawtooth or ramp). To achieve this, comparators are connected to compare the unknown voltage with the linear ramp voltage and deliver start and stop signals to the counter when coincidence occurs between ramp potential and the potential of the unknown input.

The start pulse from the comparator starts the fixed frequency Oscillator, the output from which is totalised in a count register until the stop pulse from the second comparator stops the Oscillator.

The Oscillator frequency is 200KHz and the slope of the linear ramp has been adjusted such that the counter full scale of 2000 is reached for a potential difference of 2 Volts between the comparators.

The switching sequence of the comparators provides input polarity information and this polarity is displayed for direct voltages and currents.

DC Voltmeter

For this function, the converter is preceded by an operational amplifier A1 and a resistive attenuator.

AC Voltmeter

This consists of the same circuitry as the DC voltmeter together with an amplifier and rectifier A2 connected between the output of amplifier A1 and the comparators.

Direct Current Meter

The current to be measured is passed through resistive shunts, scaled to cause a voltage drop of approximately 100mV for full scale on each range. This voltage, amplified by amplifier A1 at a gain of 20, is then applied to the comparators

Alternating Current Meter

This consists of the same circuitry as the direct current meter, together with an amplifier and rectifier A2 connected between the output of amplifier A1 and the comparators.

Resistance Meter

For this function, a calibrated direct current is applied to the resistance to be measured. The comparators are connected across the resistance and the direct current is adjusted on each range to give a voltage of 2 Volts for full scale between the comparators.

Capacity Meter

A triangular waveform between +2 and +6 Volts is generated and applied to the capacitor to be measured. The frequency of this waveform is adjusted according to the range, and the current passing through the capacitor is then measured on the alternating current measuring range, via the amplifier rectifier A2.

SECTION 3

TECHNICAL DESCRIPTION

Circuit Description

The A 1613 Digital Universal Meter contains the following sub-units:

The plug-in unit Z1 "Y9035" containing the two comparators, the triggered oscillator, and the sign bi-stable, together with the polarity display tube.

The plug-in unit Z2 "Y9135" containing the ramp generator, the timing and zero reset circuits, and a three level count decade, with display figures of 0, 1 and 2, on a cold cathode display tube.

Three plug-in decades Z3, Z4, Z5, "Y9027" with cold cathode display tubes. The switching unit Z12, "Z263" containing the following five circuits:

Attenuator Z6, "Z209 " which includes the input attenuator for the voltmeter functions, and the safety circuit which disconnects the input in the case of voltage overload.

The amplifier Z7, "Z220" which includes amplifier A1, Z8, "Z259", amplifier rectifier A2 and the resistive shunts used for current measuring functions.

Filter Z9, "Z221" a twin T-filter to improve the attenuation of series mode interference at 50Hz, together with potentiometers for calibration of the current ranges.

Capacity meter Z10, "Z224" which contains the triangular waveform generator, and the potentiometers for the calibration of the capacitance ranges.

The resistance meter Z11, "Z226" which contains the constant current generator, and potentiometers for calibration of the resistance ranges, together with potentiometers for calibration of the voltage ranges.

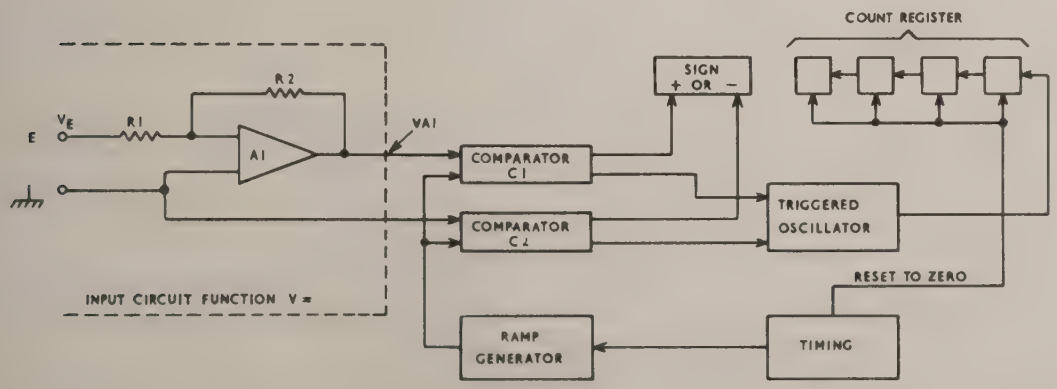
The circuits Z6, Z7, Z9, Z10 and Z11 also include the switching sections for the S1201 "function" and S1202 "range" switches.

The front of unit Z12 also carries input terminals J1201, J1202, J1203; the safety fuse XF 1201 for protection of the shunts; zero adjustment potentiometer R1203; the overload indicator I1201 and the decimal point indicator Z13, "Z268".

Sub-units Y9035, Y9135, Y9027 and Z263 are mounted on the interconnecting circuit Z14, "Z208", which also includes the power supply circuits.

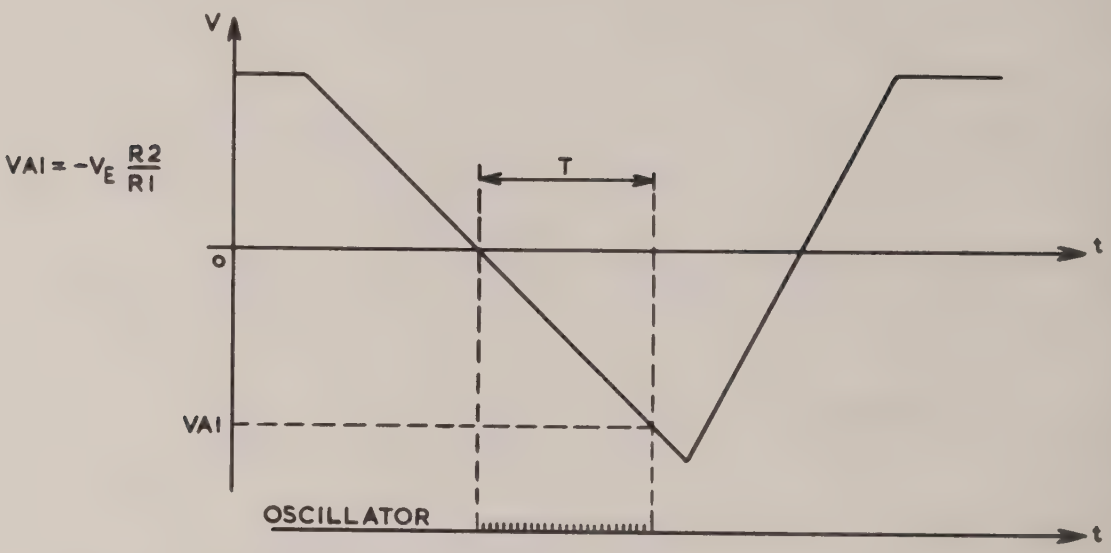
Comparator Z1 "Y9035"

The comparators determine the instant in time when two potentials are equal. In combination with the linear ramp generator, they convert the input voltage into a proportional time, which is measured by a digital time counter.

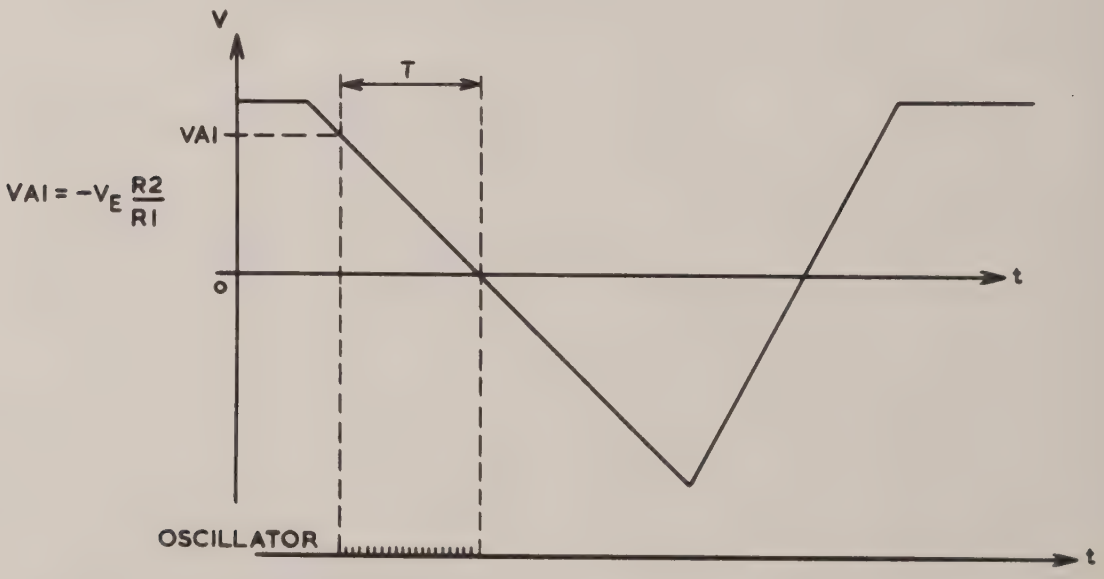


Waveforms

(a) For a positive input voltage VE.



(b) For a negative input voltage V_E.



Comparators

Comparators C1 and C2 are identical. Comparator C1 consists of:

A differential amplifier (transistor Q110) which has the voltage to be measured applied to its base, and the linear ramp applied to its emitter, through diode CR104. A bi-stable (Q111-Q112) which is turned over by Q110 at the moment of coincidence between the input and linear ramp potentials which starts or stops the oscillator, dependent on the polarity relationship between the inputs of comparators C1 and C2. At coincidence, this bi-stable, through diode CR103, cuts off the current flow through transistor Q110, resulting in a high impedance at the input of the comparators.

A logic circuit, consisting of four resistors R126, R127, R128 and R129 and two diodes CR109 and CR110, controls the triggered oscillator according to the outputs from the comparators. The first comparator reaching coincidence after reset starts the oscillator, and the second stops it.

The triggered oscillator, composed of transistors Q113 and Q114, delivers pulses which are counted by decade Z5, "Y9027", (amplitude 6 volts). The frequency is about 200KHz.

The polarity display tube is driven by the bi-stable Q115-Q116, which is itself controlled via a gating circuit from the comparators directing the pulse to Q115 or Q116, dependent on the polarity of the input voltage.

Ramp Generator Z2 "Y9135"

In the automatic mode, pulses from the gas tube I202, which is connected as a relaxation oscilator, initiates repeated measurements. These pulses control the bi-stable Q221-Q212 by cutting-off transistor Q211. The change of state of this bi-stable resets the register and comparators to zero, and starts the ramp generator.

The zero reset pulse is delivered by transistor Q213, the collector voltage of which changes from plus 6 to minus 12 volts. This pulse is completed before the linear ramp reaches its operating section.

The ramp generator, composed of transistors Q208, Q209, and Q214, arranged as an integrating operational amplifier, has a constant current applied to its input for the duration of the ramp. This current is supplied by resistor R250, which is connected to the reference diode CR1408 via the calibrating potentiometer, and it is integrated by capacitor C212 in the feedback circuit of the amplifier.

The resulting low impedance ramp on the collector of transistor Q214 is applied to the comparators C1 and C2 (Y9035).

Calibration is effected by varying the slope of the ramp.

The sub-unit Z2 also contains two bistables arranged as a counter with three stable positions (Q201-Q202; Q203-Q204). Transistors Q204, Q206 and Q207, drive the cold cathode tube V1 to display the three digits (0, 1, 2) corresponding to the three stable states of the bi-stables. This display tube V1 is the most significant (thousands) digit in the display.

Decades Z3, Z4, Z5 "Y9027"

The three decades Z3, Z4, Z5 are identical, respectively with input frequencies of 2KHz, 20KHz and 200KHz.

The decade Y9027 is composed of four bi-stables, the first of which (Q301-Q302) divides the input frequency by two. The second and third bi-stables operate as a scale of four. The gate CR304, driven by the fourth bi-stable (R343) connects pulses from the first bi-stable to the second bi-stable when the fourth bi-stable is in the "O" state.

The third bi-stable sets the fourth to the "1" state at transition from 7 to 8. The first sets the fourth back to "O" state at transistion from 9 to 0, and the fourth then supplies a positive edge to the next counting stage.

The digital display tube V301, mounted on the decade board, is a gas tube consisting of one anode and 10 cathodes. The cathodes are driven by 10 npn transistors (Q309-Q318).

The anode of the display tube is supplied with a voltage of approximately +200V, through resistor R356. When one of the 10 transistors conducts it illuminates its corresponding digit. The bases of these transistors are driven in pairs by a resistor logic network connected to the last three bi-stables; the first flip-flop then gives parity indication on the emitters.

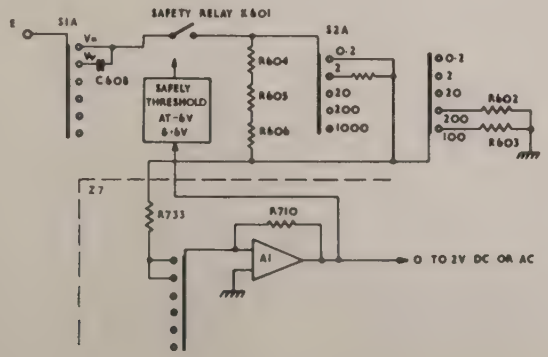
Switching Unit Z12, "Z263"

The switching unit converts the input parameter into a DC voltage, this voltage is scaled by the range switch to a level between -2 volts and +2 volts for full scale reading of the parameter selected, which is the measurement range of the comparators.

Attenuator Z6 "Z209"

The resistive attenuator is used for both direct and alternating voltage measurements. It determines the gain of the operational amplifier A1 as follows:-

10 on 0.2V range
1 on 2V range
0.1 on 20V range
0.01 on 200V range
0.001 on 1000V range.



The sub-unit Z6 also contains the safety relay circuit which protects the attenuators against overload. The overload is taken from the output of amplifier A1, to bi-stable Q603-Q604 which is turned over when the amplifier's output is lower than - 6 volts or higher than +6 volts. These two thresholds are defined by the base voltage of transistor Q601 and the emitter voltage of transistor Q602. The relay is automatically re-set by the application of the zero reset pulse to the base of transistor Q603.

The transistor Q605 drives the pilot lamp I1201 which indicates an overload.

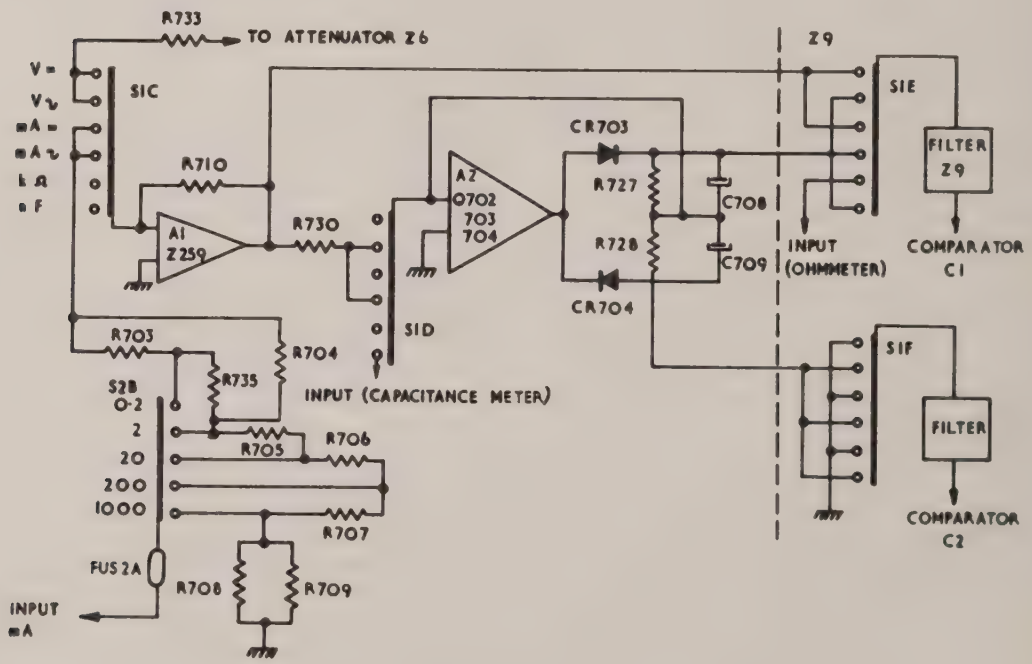
Amplifier Z7 "Z220"

Amplifier A1 is in the form of a sub-module mounted on circuit board Z7. It is used as an operational amplifier for the functions of direct and alternating voltage, and direct and alternating current measurement. For current measurements, the gain is 20, which gives 2 volts at the output for 100mV across the shunt terminals.

For the alternating voltage and current measurements, amplifier A1 is followed by amplifier detector A2, which converts the mean alternating current into a proportional direct voltage.

Amplifier A2 consists of transistors Q702-Q703-Q704 and rectification is performed by diodes CR703 and CR704. The detection time constant (R727-R728-C708-C709) maintains measurement accuracy at low frequencies (40Hz), and provides a DC voltage equal to the RMS voltage of the sinewave applied to resistor R730. The mean current detected is equal to half the mean alternating current applied to the amplifier input. Proportionality between the direct current output and the alternating current input is ensured by 100% feedback in AC, the feedback loop includes the detecting diodes.

The amplifier detector A2 is also in circuit when the instrument is used as a capacitance meter.



Filter Z9 "Z221"

In order to achieve a high rejection of interfering voltages, particularly at 50Hz, a twin T-filter preceded by an RC filter, is connected in front of comparator C1. On the "comparator C1" sub-unit, a third RC filter is connected at the input of comparator C1.

Two RC filters are connected in front of comparator C2. Potentiometer R905 is adjusted to give maximum attenuation by the twin T-filter at 50Hz.

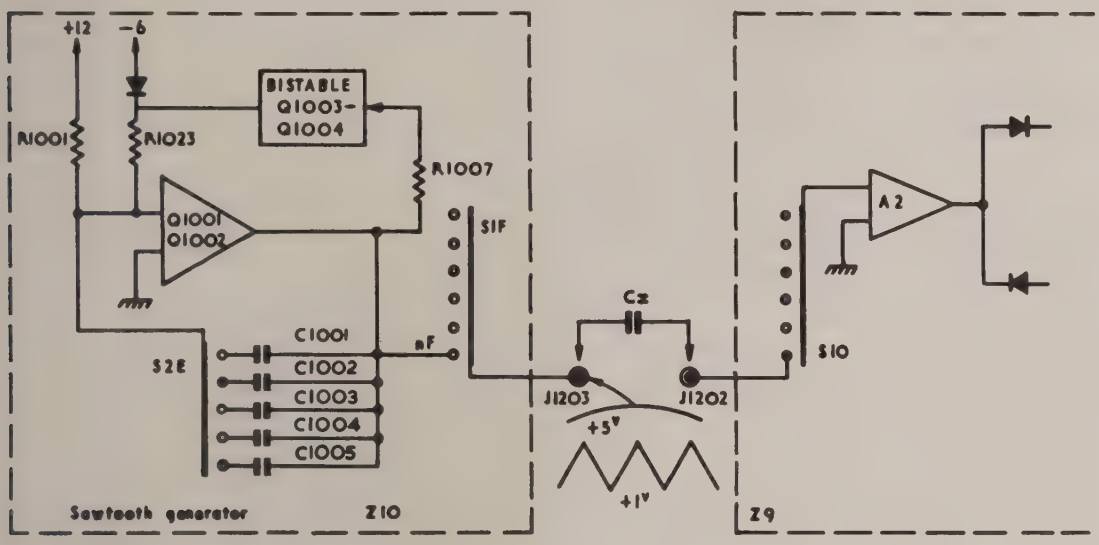
Capacitance Meter, Circuit Z10 "Z224"

Capacitance measurement is performed by measuring the current flowing through a capacitor when a sawtooth voltage waveform is applied across it.

The sawtooth waveform generator consists of an integrating amplifier Q1001 and Q1002 controlled by two calibrated currents of opposite polarities. One current is switched by bi-stable Q1003-Q1004, which, driven by the amplifier output, defines the +1 volt and +5 volt limits on the sawtooth waveform. The slopes of the sawtooth waveform are defined by the integrating capacitors which are selected by range selector S2E.

Calibration on each range is achieved by adjustment of the slope of the ramp generated by sub-unit Y9135. The slope is adjusted by potentiometers R1006, R1012, R1011, R1010, and R1009, respectively for each range.

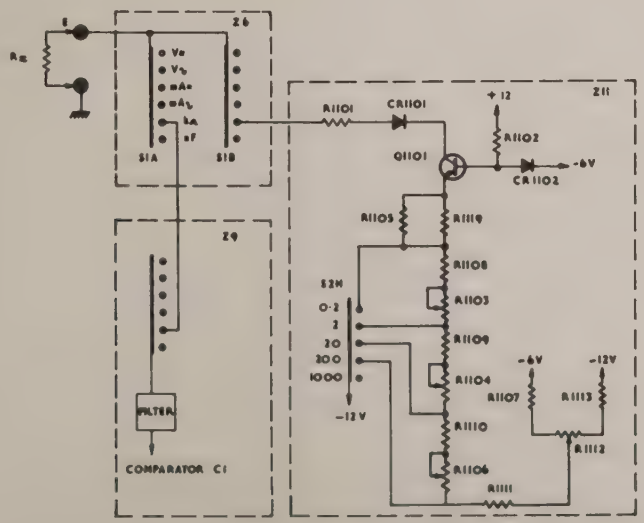
The current flowing through the capacitor being measured is converted into direct voltage by amplifier detector A2.



Resistance Meter Z11 "Z226"

The resistance meter consists of a current source which is calibrated on each range, to give a potential difference of two volts across the resistor being measured when its value is equal to full scale of the range in use. The voltage is applied directly to the comparators.

The diode CR1101 protects the current source against negative voltage inadvertently applied to the input terminals of the instrument.



Power Supply Z14 "Z208"

Mains input to the power supply transformer is via a mains selector panel on the rear of the instrument. This selector panel contains a safety fuse.

An unregulated HT supply of approximately +200 volts is obtained from a voltage doubler.

The plus 12 volt rail is regulated by amplifier Q1408-Q1409-Q1407-Q1406, which is in turn supplied from an unregulated DC source of approximately 20 volts across the capacitor C1404. This stabilised rail is referenced to zener diode CR1408, which also acts as a reference level for the ramp generator Z2.

The plus 6 volt rail is obtained from the +12 volt rail via zener diode CR1409.

The -12 volt rail is regulated by amplifier Q1403-Q1404-Q1401-Q1402 from an unregulated DC voltage of approximately 20 volts across the capacitor C1403. This rail is stabilised by the +12 volt rail through a bridge R1401-R1411.

The negative 6 volt rail is obtained from the negative 12 volt rail, by means of a resistor bridge R1417-R1418 and a transistor Q1405 connected as an emitter follower.

The power supply circuits are mounted on the printed circuit board at the rear of the instrument. They require no adjustment. The accuracy of the various rails is ± 10%, with the exception of the +6.2 volt reference rail which is accurate to ± 5%.

COMPONENT PARTS LIST

COMPONENT PARTS LIST
Abbreviations

Circuit References

R	Fixed Resistor [Ω]
C	Fixed Capacitor [μF]
Q	Transistor
CR	Diode
RV	Variable Resistor [Ω]
S	Switch
SKT	Socket
FS	Fuse
LP	Lamp
TL	Terminal
T	Transformer
CM	Counter Module
V	Valve
X	Photo-Conductor
MSP	Mains Selector Panel

COMPONENT PARTS LIST
for
Comparator & Oscillator Y9035 "Z1"

Cct. Ref.	General Description		
R101	100k	½W	5%
R102	12k	¼W	5%
R103	12k	¼W	5%
R104	10k	¼W	5%
R105	2.2k	¼W	5%
R106	22k	¼W	5%
R107	15k	¼W	5%
R108	3.9k	¼W	5%
R109	10k	¼W	5%
R110	10k	¼W	5%
R111	2.2k	¼W	5%
R112	18k	¼W	5%
R113	150k	¼W	5%
R114	100k	½W	5%
R115	12k	¼W	5%
R116	12k	¼W	5%
R117	10k	¼W	5%
R118	2.2k	¼W	5%
R119	22k	¼W	5%
R120	15k	¼W	5%
R121	10k	¼W	5%
R122	10k	¼W	5%
R123	2.2k	¼W	5%
R124	18k	¼W	5%
R125	150k	¼W	5%
R126	10k	¼W	5%
R127	10k	¼W	5%
R128	10k	¼W	5%
R129	10k	¼W	5%
R130	100k	¼W	5%
R131	27k	¼W	5%
R132	12k	¼W	5%
R133	2.2k	¼W	5%
R134	1k	¼W	5%
R135	3.9k	¼W	5%
R136	10k	¼W	5%
R137	10k	¼W	5%
R138	56k	¼W	5%
R139	330k	¼W	5%
R140	33k	½W	5%
R141	180k	¼W	5%
R142	56k	¼W	5%
R143	220k	¼W	5%
R144	100k	¼W	5%
R145	5.6k	¼W	5%
R146	12k	¼W	5%
R147	10k	¼W	5%
R148	10k	¼W	5%

C101	0.22μF	125V
C102	10nF	125V
C103	470pF	
C104	0,22μF	125V
C105	10nF	125V
C106	470pF	
C107	47pF	
C108	47pF	
C109	220pF	
C110	220pF	
C111	560pF	160Vcc ±2,5%
C112	470pF	
C113	470pF	
C114		
C115		

CR101	Diode	OA95
CR102	Diode	TF51
CR103	Diode	OA95
CR104	Diode	TF51
CR105	Diode	OA95
CR106	Diode	OA95
CR107	Diode	OA95
CR108	Diode	OA95
CR109	Diode	OA95
CR110	Diode	OA95
CR111	Diode	OA95
CR112	Diode	OA95
CR113	Diode	OA95
CR114	Diode	OA95
CR115	Diode	OA95

Q107	Transistor	2N1711
Q108	Transistor	SFT208

Q109	Transistor	SFT208
Q110	Transistor	2N1711
Q111	Transistor	SFT208
Q112	Transistor	SFT208
Q113	Transistor	SFT208
Q114	Transistor	2N711A
Q115	Transistor	90T2
Q116	Transistor	90T2
Q117	Transistor	SFT208

COMPONENT PARTS LIST
for
Ramp Generator Y 9135 "Z2"

Cct. Ref.	General Description		
R201	18k	1/8W	±5%
R202	15k	1/8W	±5%
R203	10k	1/8W	±5%
R204	1M	1/4W	5%
R205	2.2k	1/8W	±5%
R206	15k	1/8W	±5%
R207	47k	1/8W	±5%
R208	15k	1/8W	±5%
R209	1M	1/8W	±5%
R210	18k	1/8W	±5%
R211	2.2k	1/8W	±5%
R212	15k	1/8W	±5%
R213	47k	1/8W	±5%
R214	10k	1/8W	±5%
R215	10k	1/8W	±5%
R216	220k	1/4W	5%
R217	18k	1/8W	±5%
R218			
R219	15k	1/8W	±5%
R220	10k	1/8W	±5%
R221	15k	1/8W	±5%
R222	2.2k	1/8W	±5%
R223	15k	1/8W	±5%
R224	47k	1/8W	±5%
R225	15k	1/8W	±5%
R226	2.2k	1/8W	±5%
R227	15k	1/8W	±5%
R228	47k	1/8W	±5%
R229	15k	1/8W	±5%
R230	2.2k	1/8W	±5%
R231	22k	1/8W	±5%
R232	1.5k	1/8W	±5%
R233	10k	1/8W	±5%
R234	2.2k	1/8W	±5%
R235	2.2k	1/8W	±5%
R236	4.7k	1/8W	±5%
R237	1.5k	1/8W	±5%
R238	2.7k	1/8W	±5%
R239	22k	1/8W	±5%
R240	22	1/8W	±5%
R241	10k	1/8W	±5%
R242	22k	1/8W	±5%
R243	5.1M	1/8W	±5%
R244	10M	1/8W	5%
R245	10M	1/8W	5%
R246	3.9k	1/8W	±5%
R247	2.2k	1/8W	±5%
R248	1k	1/8W	±5%
R249	560k	1/4W	5%
R250	4,53k		
R251			
R252	22k	1/8W	5%
R253	5.6k	1/8W	5%
R254	150	1/8W	5%
R255	1k	1/8W	5%
R256	6.8k	1/8W	5%
R257	680	1/8W	5%
R258	8.2k	1/8W	5%
R259	100	1/8W	5%
R260	33	1/8W	5%
R261	2.2k	1/8W	5%
R262	820	1/2W	5%
R263	10k	1/8W	±5%
R264	33k	1/2W	5%
R265	680k	1/8W	±5%

C201	1nF		
C202	1nF		
C203	1nF		
C204	47nF	125V	
C205	47nF	125V	
C206	10nF	125V	
C207	0.1μF	125V	
C208	0.1μF	125V	
C209	10μF	6V	
C210	220pF		
C211	47nF	125V	
C212	4.7μF	63V	±5%

CR201	Diode	OA95
CR202	Diode	OA95
CR203	Diode	OA95
CR204	Diode	OA95
CR205	Diode	TF51
CR206	Diode	OA95
CR207	Diode	TF51
CR208	Diode	1N646

Q201	Transistor	SFT208
Q202	Transistor	SFT208
Q203	Transistor	SFT208
Q204	Transistor	SFT208
Q205	Transistor	2N1990R
Q206	Transistor	2N1990R
Q207	Transistor	2N1990R
Q208	Transistor	2N1711
Q209	Transistor	2N1305
Q210	Transistor	2N1304
Q211	Transistor	2N1305
Q212	Transistor	2N1305
Q213	Transistor	2N1990R
Q214	Transistor	2N1304

COMPONENT PARTS LIST
for
Decade "Z3-Z4-Z5" Y 9027

Cct. Ref.	General Desctiption
C301	470pF
C302	220pF
C303	2.2nF
C304	2 2nF
C305	220pF
C306	470pF
C307	470pF
C308	220pF
C309	220pF
C310	470pF
C311	470pF
C312	220pF
C313	220pF
C314	470pF
C315	470pF
C316	220pF
C317	220pF
C318	470pF
C319	10nF

CR301	Diode	OA92
CR302	Diode	OA92
CR303	Diode	OA92
CR304	Diode	OA92
CR305	Diode	OA92
CR306	Diode	OA92
CR307	Diode	OA92
CR308	Diode	OA92
CR309	Diode	OA92

R301	47k	1/8W	5%
R302	3.3k	1/8W	5%
R303	2.2k	1/8W	5%
R304	15k	1/8W	5%
R305	100	1/8W	5%
R306	100	1/8W	5%
R307	47k	1/8W	5%
R308	15k	1/8W	5%
R309	3.3k	1/8W	5%
R310	2.2k	1/8W	5%
R311	15k	1/8W	5%
R312	2.2k	1/8W	5%
R313			
R314	10k	1/8W	5%
R315	15k	1/8W	5%
R316	47k	1/8W	5%
R317	15k	1/8W	5%
R318	2.2k	1/8W	5%
R319	15k	1/8W	5%
R320	15k	1/8W	5%
R321	15k	1/8W	5%
R322	47k	1/8W	5%
R323	15k	1/8W	5%
R324	2.2k	1/8W	5%
R325	10k	1/8W	5%
R326	15k	1/8W	5%
R327	15k	1/8W	5%
R328	15k	1/8W	5%
R329	10k	1/8W	5%
R330	15k	1/8W	5%
R331	47k	1/8W	5%
R332	15k	1/8W	5%
R333	2.2k	1/8W	5%
R334	15k	1/8W	5%
R335	15k	1/8W	5%
R336	47k	1/8W	5%
R337	15k	1/8W	5%
R338	2.2k	1/8W	5%
R339	10k	1/8W	5%
R340	15k	1/8W	5%
R341	15k	1/8W	5%
R342	15k	1/8W	5%
R343	15k	1/8W	5%
R344	15k	1/8W	5%
R345	15k	1/8W	5%
R346	47k	1/8W	5%
R347	15k	1/8W	5%
R348	2.2k	1/8W	5%
R349	15k	1/8W	5%
R350	15k	1/8W	5%
R351	47k	1/8W	5%
R352	15k	1/8W	5%
R353	2.2k	1/8W	5%
R354	15k	1/8W	5%
R355	10k	1/8W	5%
R356	33k	1/2W	5%
R357	220k	1/8W	5%
R358	220k	1/8W	5%
R359	220k	1/8W	5%
R360	220k	1/8W	5%
R361	220k	1/8W	5%
R362	220k	1/8W	5%
R363	220k	1/8W	5%
R364	220k	1/8W	5%
R365	220k	1/8W	5%
R366	220k	1/8W	5%
R367	82k	1/8W	5%
R368	330k	1/8W	5%

Q301	Transistor	SFT208
Q302	Transistor	SFT208
Q303	Transistor	SFT208
Q304	Transistor	SFT208
Q305	Transistor	SFT208
Q306	Transistor	SFT208
Q307	Transistor	SFT208
Q308	Transistor	SFT208
Q309	Transistor	90T2
Q310	Transistor	90T2
Q311	Transistor	90T2
Q312	Transistor	90T2

Q313	Transistor	90T2
Q314	Transistor	90T2
Q315	Transistor	90T2
Q316	Transistor	90T2
Q317	Transistor	90T2
Q318	Transistor	90T2

COMPONENTS PARTS LIST
for
Attenuator Z209 "Z6"

Cct. Ref.	General Description		
R601	200k		±1%
R602	2.21k		±1%
R603	200		±1%
R604	665k		±1%
R605	665k		±1%
R606	649k		±1%
R607	33k	1/8W	±5%
R608	33k	1/8W	±5%
R609	10k	1/8W	±5%
R610	47k	1/8W	±5%
R611	2.7k	1/8W	±5%
R612	18k	1/8W	±5%
R613	47k	1/8W	±5%
R614	27k	1/8W	±5%
R615	4.7k	1/8W	±5%
R616	10k	1/8W	±5%
R617	2.2k	1/8W	±5%
R618	47k	1/8W	±5%

C601	5.6pF		
C602	Not Used		
C603	Not Used		
C604	Not Used		
C605	68pF		
C606	68pF		
C607	10pF		
C608	4.7µF	63V	±20%

CR601	Diode	TF51
CR602	Diode	TF51
CR603	Diode	TF51

Q601	Transistor	2N1304
Q602	Transistor	2N1305
Q603	Transistor	2N1305
Q604	Transistor	2N1305
Q605	Transistor	2N1305

K601	Relay

COMPONENT PARTS LIST
for
Amplifier Z220 "Z7"

Cct. Ref.	General Description		
R701	10k	1/8W	±5%
R702	100k	1/8W	±5%
R703	2.5k	1/8W	±5%
R704	13.3k		
R705	45		±2%
R706	4.5		±2%
R707	0.45		±2%
R708	0.1		±2%
R709	0.1		±2%
R710	200k		
R711	4.7k	LOI A	±20%
R712	100k	1/8W	±5%
R713	47		±5%
R714	47		±5%
R715	100k		±5%
R716	66.5k		
R717	100	1/8W	±5%
R718	15k	1/8W	±5%
R719	82k	1/8W	±5%
R720	82k	1/8W	±5%
R721	18k	1/8W	±5%
R722	100	1/8W	±5%
R723	220	1/8W	±5%
R724	5,6k	1/8W	±5%
R725	22k	1/8W	±5%
R726	100k	1/8W	±5%
R727	5,9k		
R728	5,9k		
R729	100k	1/8W	±5%
R730	4,87k		
R731	100k		±20%
R732	91k	1/8W	±5%
R733	20k		
R734	100Ω	1/8W	±5%
R735	576Ω		

C701	3/12pF	
C702	15pF	
C703	680pF	
C704	10 µF	6 V
C705	22nF	160 V
C706	10 µF	10 V
C707	0.47 µF	60V
C708	10 µF	10 V
C709	10 µF	10 V
C710	0.47 µF	60 V
C711	10nF	400 V
C712	3.3pF	

CR701	Diode	TF51
CR702	Diode	TF51
CR703	Diode	TF51
CR704	Diode	TF51
CR705	Diode	SCE1
CR706	Diode	SCE1

Q701	Transistor	2N2905
Q702	Transistor	2N1711
Q703	Transistor	2N1711
Q704	Transistor	2N2905

Comprising an Operational Amplifier type Z259

R801	56k	±5%
R802	100k	±5%
R803	56k	±5%
R804	5.6k	±5%
R805	6.2k	±5%
R806	470	±5%
R807	5.6k	±5%
R808	10	±5%
R809	10	±5%

CR801	Diode	TF51
CR802	Diode	TF51
CR803	Diode	TF51
CR804	Diode	TF51

Q801	Transistor	BSY80
Q802	Transistor	BSY80
Q803	Transistor	2N2907
Q804	Transistor	2N2907
Q805	Transistor	2N956
Q806	Transistor	2N1711
Q807	Transistor	2N2905

COMPONENT PARTS LIST
for
Filter 50Hz Z221 "Z9"

Cct. Ref.	General Description		
R901	100k	1/8W	5%
R902	68k	1/8W	5%
R903	68k	1/8W	5%
R904	24k	1/8W	5%
R905	20k		
R906	100k	1/8W	5%
R907	120k	1/8W	5%
R908	500		
R909	500		
R910	500		
R911	500		
R912	500		
R913	1.33k		

C901	0.47 µF
C902	0.1 µF
C903	47nF
C904	47nF
C905	0.47 µF

COMPONENT PARTS LIST
for
Capacity Meter X224 "Z10"

Cct. Ref.	General Description		
R1001	56k	1/8W	±5%
R1002	12k	1/4W	5%
R1003	9.1k	1/4W	5%
R1004	390	1/4W	5%
R1005			
R1006	2k		
R1007	3.3k	1/4W	5%
R1008	15k	1/4W	±5%
R1009	1k		±20%
R1010	1k		±20%
R1011	1k		±20%
R1012	1k		±20%
R1013	510	1/3W	±2%
R1014	2.2k	1/4W	±5%
R1015	6.8k	1/4W	±5%
R1016	10	1/4W	±5%
R1017	510		
R1018	2k		
R1019	2.2k	1/4W	±5%
R1020	10k	1/4W	±5%
R1021	100k	1/8W	±5%
R1022	1.43k	1/3W	±5%
R1023	9.09k		

C1001	68pF	400V	±5%
C1002	1nF	400V	±5%
C1003	10nF	160V	±5%
C1004	0.1µF	160V	±5%
C1005	1µF	63V	±5%
C1006	1nF	400V	±5%

CR1001	Diode	TF51
CR1002	Diode	TF51

Q1001	Transistor	2N1711
Q1002	Transistor	2N1711
Q1003	Transistor	2N1305
Q1004	Transistor	2N1305

COMPONENT PARTS LIST
for
Ohm-meter Z226 "Z11"

Cct. Ref.	General Description		
R1101	22	¼W	5%
R1102	6.8k	¼W	5%
R1103	500		

R1104	5k		
R1105	1180	½W	1%
R1106	50k		
R1107	390k	½W	5%
R1108	5.11k	1/3W	5%
R1109	51.1k	1/3W	5%
R1110	523k		1%
R1111	4.12M		
R1112	50k		
R1113	100k	½W	5%
R1114	120	½W	5%
R1115	250		
R1116	250		
R1117	250		
R1118	250		
R1119	1180	½W	1%

CR1101	Diode	SCE1
CR1102	Diode	TF51
Q1101	Transistor	

COMPONENT PARTS LIST
for
Switching Unit Z263 "Z12"

Cct. Ref.	General Description		
R1201	270k	1/8W	5%
R1202	10k	1/8W	5%
R1203	22k		
R1204	10k	1/8W	5%
R1205	1M	1/4W	5%
XF1201	Fuseholder		
F1201	DI 2A		
XI1201	Bulbholder		
I1201	Bulb		
J1201	Terminal Black		
J1202	Terminal Red		
J1203	Terminal Green		

COMPONENT PARTS LIST
for
Decimal Point Indication Z268 "Z13"

Cct. Ref.	General Description
I1301	Neon
I1302	Neon
I1303	Neon
I1304	Neon

COMPONENT PARTS LIST
for
Power Supply and Display Z208 "Z14"

Cct Ref.	General Description		
R1401	68k	1/8W	5%
R1402	100k	1/8W	5%
R1403	4.7k	1/8W	5%
R1404	1k	1/8W	5%
R1405	5.6k	1/8W	5%
R1406	5.6k	1/8W	5%
R1407	560	1/8W	5%
R1408	5.6k	1/8W	5%
R1409	2.2k	1/8W	5%
R1410	2.2k	1/3W	2%
R1411	2.2k	1/3W	2%
R1412	6.2k	1/3W	2%
R1413	5.6k	1/3W	2%
R1414	1k	1/8W	5%
R1415	47	1/8W	5%
R1416	680	1/2W	5%
R1417	1k	1/8W	5%
R1418	1k	1/8W	5%
R1419	680	1/8W	5%
R1420	1k		
R1421	4.7k		

C1401	8µF	
C1402	8µF	
C1403	200µF	30V
C1404	200µF	30V
C1405	100µF	15V
C1406	100µF	15V
C1407	100µF	15V
C1408	100µF	15V
C1409	470pF	
C1410	470pF	

CR1401	Diode	SCE4
CR1402	Diode	SCE4
CR1403	Diode	SCE1
CR1404	Diode	SCE1
CR1405	Diode	SCE1
CR1406	Diode	SCE1
CR1407	Diode	OA95
CR1408	Diode	1N3496
CR1409	Diode	Z2B56

Q1401	Transistor	40391
Q1402	Transistor	2N1711
Q1403	Transistor	2N1305
Q1404	Transistor	2N1305
Q1405	Transistor	2N1305
Q1406	Transistor	BSY84
Q1407	Transistor	2N1305
Q1408	Transistor	2N1711
Q1409	Transistor	2N1711

J1401	Power Socket
J1402	Insulated Socket Red
J1403	Insulated Socket Black
J1404	Socket
J1405	Print-out Socket
J1406	Connector
J1407	Connector
J1408	Connector
J1409	Connector
J1410	Connector

SECTION 4

MAINTENANCE

Basic Calibration

A basic calibration of the analogue-to-digital converter can be carried out without removing the rear panel. It is recommended that this adjustment is carried out at approximately monthly intervals. The instrument should be allowed to warm up for at least 1 hour before adjustments are made.

To calibrate, select the two volt DC range and connect a low resistance (less than 100Ω) DC voltage source of 1.8 volts ± 0.05% to the input terminals. If the A1613 does not display 1.800, adjust it to this value by means of potentiometer R1420 which is accessible via a hole in the rear panel of the instrument.

Removal of the Instrument from its Case

To carry out a complete calibration it is necessary to remove the instrument from its case as follows:-

Remove the four outer fixing screws and take off the rear panel.

Remove the two inner fixing screws, which hold the main printed circuit board, in the top corners of the case.

Slide the instrument backwards out of the cabinet.

All the potentiometers are accessible from the top of the chassis with the exception of potentiometer R1420

Calibration Table

Parameter Adjusted	Function Switch S1	Range Switch S2	Input Across Terminals J1201 and J1202	Adjust Display	Adjust Component
Comparator zero	KΩ	20	short circuit	00.00	R1421
A1 zero (voltage)	+ρ− mA=VOLT BALANCE	20	short circuit	00.00	R711
A2 zero (current)	V=	2	open circuit	0.000	R1203
200mV = range	V=	0.2	180mV=(±2.10^{-4})	.1800	R1420
2V = range	V=	2	1.8V=(±2.10^{-4})	1.800	R1115
20V = range	V=	20	18V=(±2.10^{-4})	18.00	R1116
200V = range	V=	200	180V=(±2.10^{-4})	180.0	R1117
1000V = range	V=	1000	1000V=(±2.10^{-4})	1000	R1118
200μA = range	mA=	0.2	180μA=(±5.10^{-4})	.1800	R908
2mA = range	mA=	2	1800μA=(±5.10^{-4})	1.800	R909
20mA = range	mA=	20	18mA=(±5.10^{-4})	18.00	R910
200mA = range	mA=	200	180mA=(±5.10^{-4})	180.0	R911
1A = range	mA=	1000	1A=(±5.10^{-4})	1000	R912
AC Voltmeter	V~	2	1.8V (+5.10^{-4}) 120Hz	1.800	R731
AC Voltmeter	V~	2	1.8V (+5.10^{-4}) 5kHz	1.800	C701
200Ω range	KΩ	0.2	180Ω (±5.10^{-4})	.1800	R1018
2KΩ range	KΩ	2	1800Ω (±5.10^{-4})	1.800	R1103
20KΩ range	KΩ	20	18KΩ (±5.10^{-4})	18.00	R1104
200KΩ range	KΩ	200	180KΩ (±5.10^{-4})	180.0	R1106
1000KΩ range	KΩ	1000	1MΩ (±5.10^{-4})	1000	R1112
1μF range	nF	1000	1μF (±0.1%) between input terminal J1202 and J1203	1000	R1006
200nF range	nF	200	180nF (±0.1%)	180.0	R1012
20nF range	nF	20	18nF (±0.1%)	18.00	R1011
2nF range	nF	2	1800pF (±0.1%)	1.800	R1010
200pF range	nF	0.2	180pF (±0.1%)	.1800	R1009
50Hz filter	V=	0.2	180mV 50Hz ± 1%	.0000	R905

which is at the rear, and the potentiometer R731 which is on the righthand side.

Removal of a Plug-in Unit

To remove any of the Y sub-units, remove the two fixing screws from the decimal point display circuit Z13 and take off this circuit to allow the sub-unit to be extracted.

Removal of the Switching Unit Z12

To remove the switching unit, unscrew the three screws connecting it to the interconnection board Z14 and pull it forwards.

To extract a circuit board from the switching unit, remove the locking bar (screw on the front, above the potentiometer), and then the shafts of both switches (two screws per switch on the front panel). The switches should be handled very carefully to avoid damaging the switch wafers.

In some cases connections must be unsoldered in order to remove a printed circuit board.

Complete calibration of the A1613

Some of the adjustments are common to several parameters, they must therefore be carried out in the sequence shown in the table.

Calibration must be performed when the instrument is at its normal working temperature which it reaches one hour after switch-on. The instrument must be covered up when withdrawn from the cabinet to ensure that this temperature is reached and maintained.

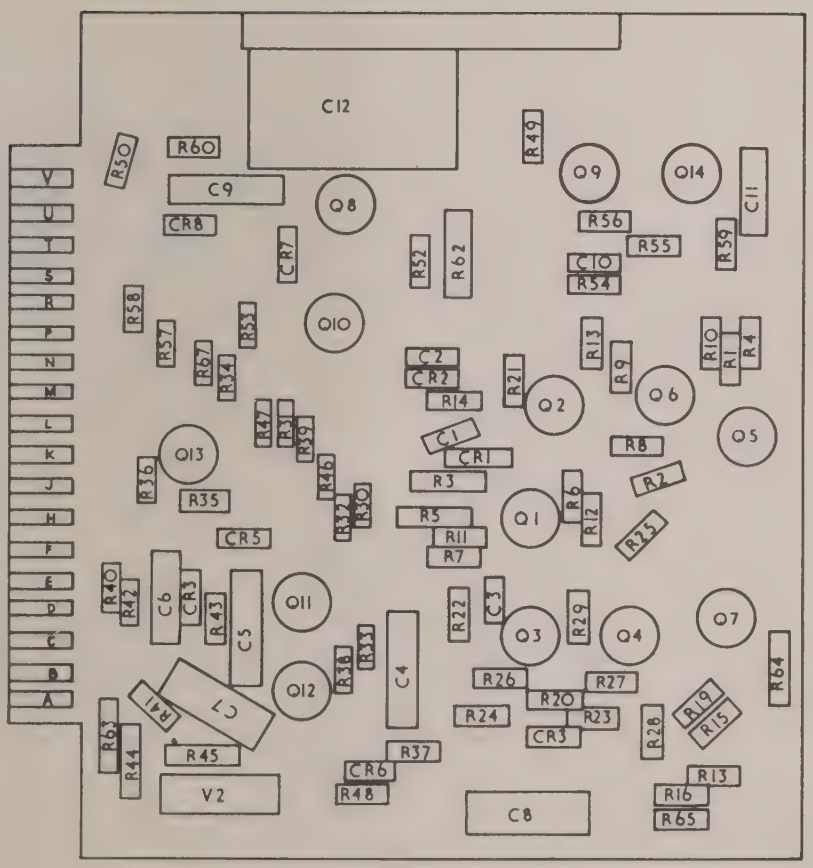
It is recommended that a complete calibration is carried out every 6 months.

Two spare fuses are fixed on the chassis at the rear of the instrument. The two amp fuse is for the ammeter shunt protection circuit (XF1201 holder on the front panel) and the 250mA fuse is for power supply protection (XF1401 holder on the rear panel in the mains selector.)

Sub Assemblies

Z.1	Comparator Oscillator Y9035
Z.2	Ramp Generator Y9135
Z3	Display decade Y9027
Z4	Display decade Y9027
Z5	Display decade Y9027
Z6	Attenuator Z209
Z7	Amplifier Z220
Z8	Operational Amplifier Z259
Z9	50Hz Filter Z221
Z10	Capacitance Meter Circuit Z224
Z11	Resistance Meter Circuit Z226
Z12	Switching Unit Z263 which includes
Z13	Decimal point indicator Z268
Z14	Power Supply Z208

Input
Weight 1
−6 V
+ 12V
Weight 2
Output
Ramp
Printout
Overload
Ext. Control
−12V
+6V
Reset
Manual



RAMP GENERATOR Y9135

Count

Balance

Ground

−6

+12

Overload

Comparator

−12

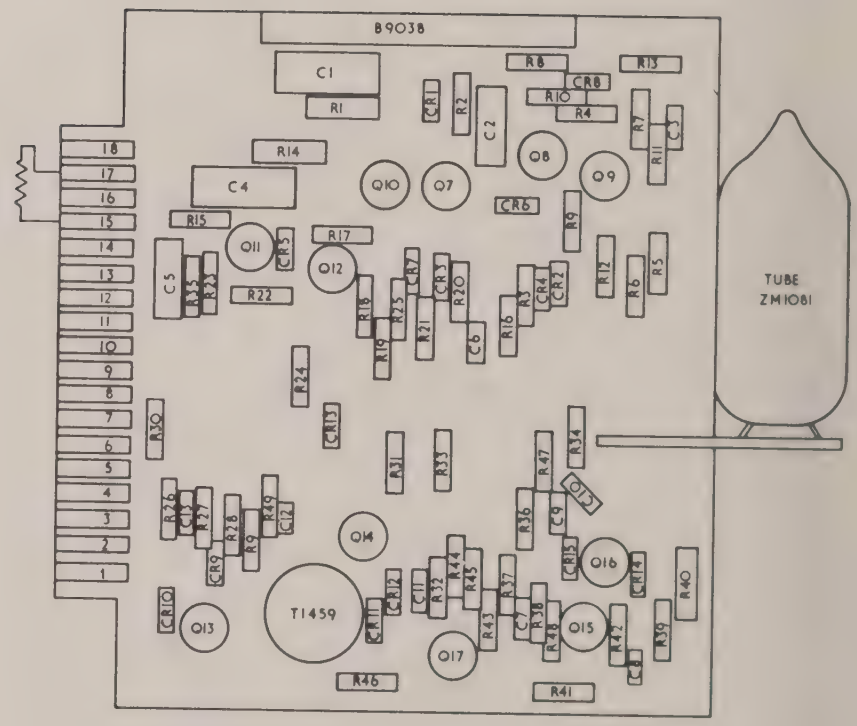
+6

Zero

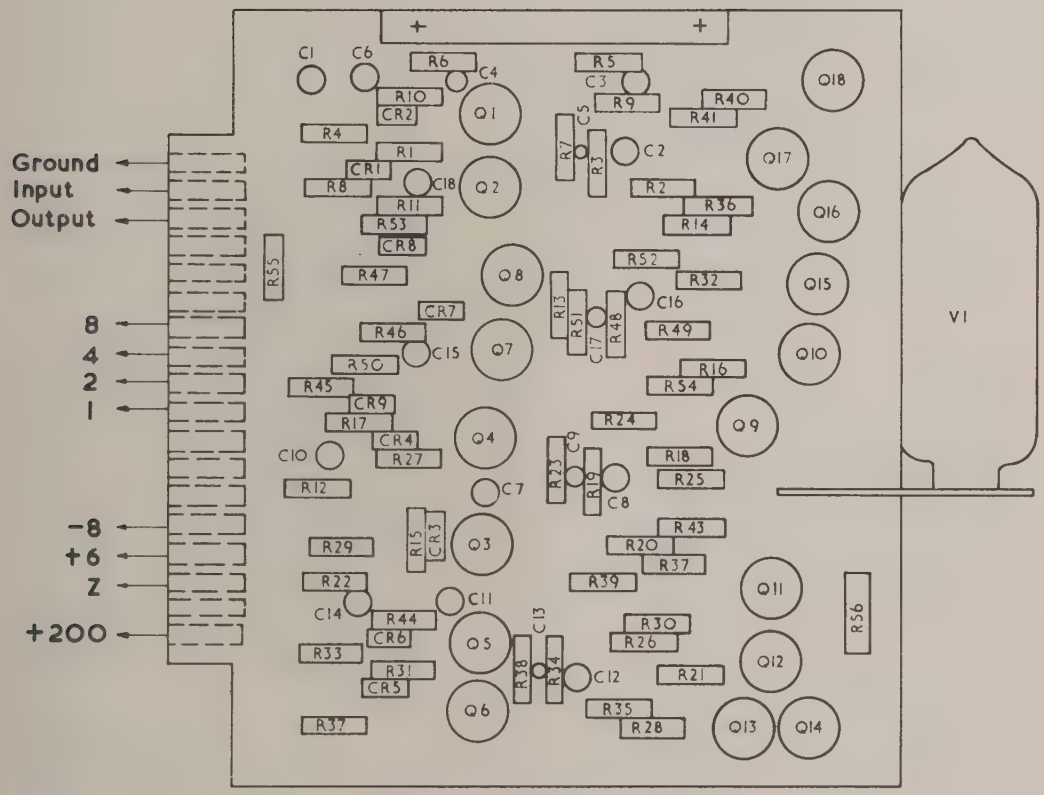
Ground

Sign Print

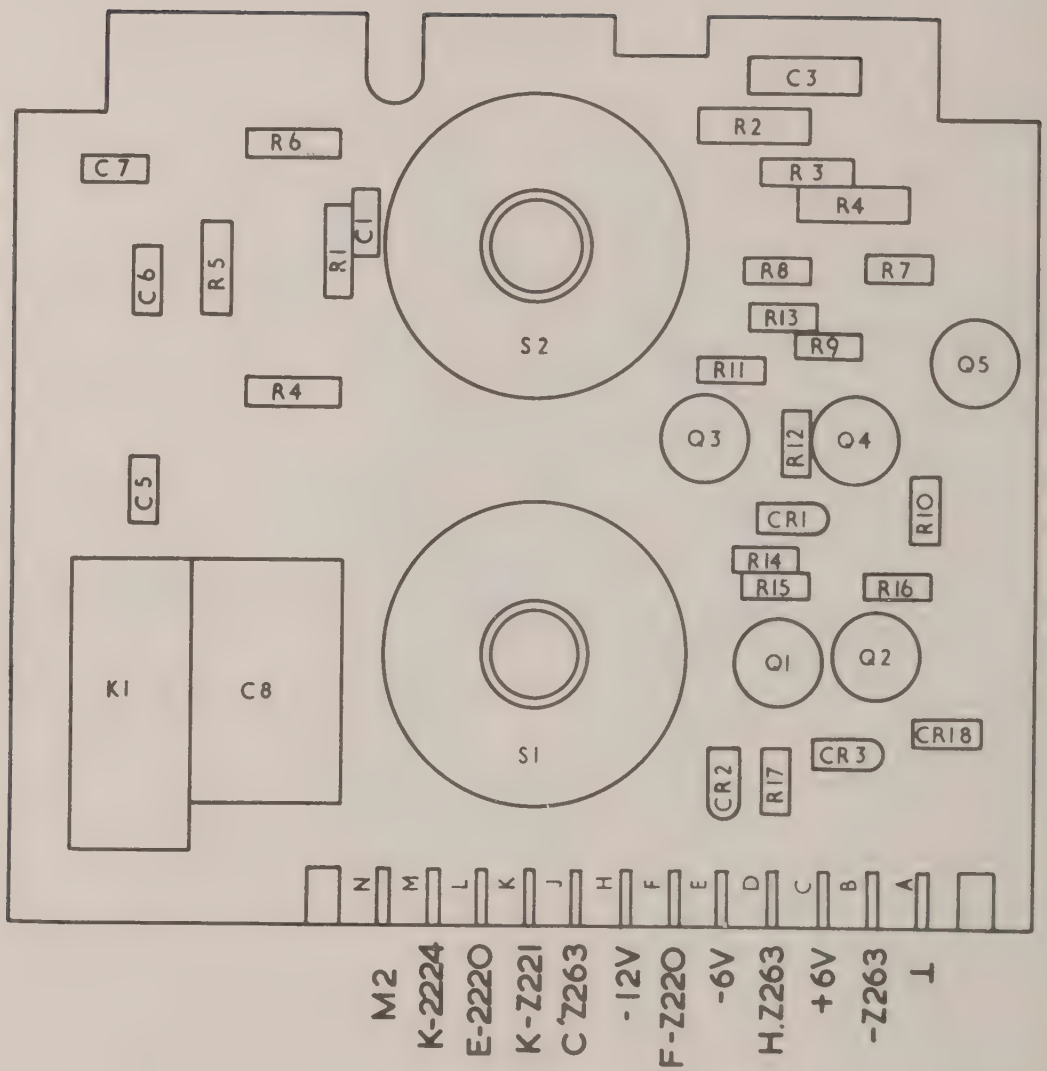
+200



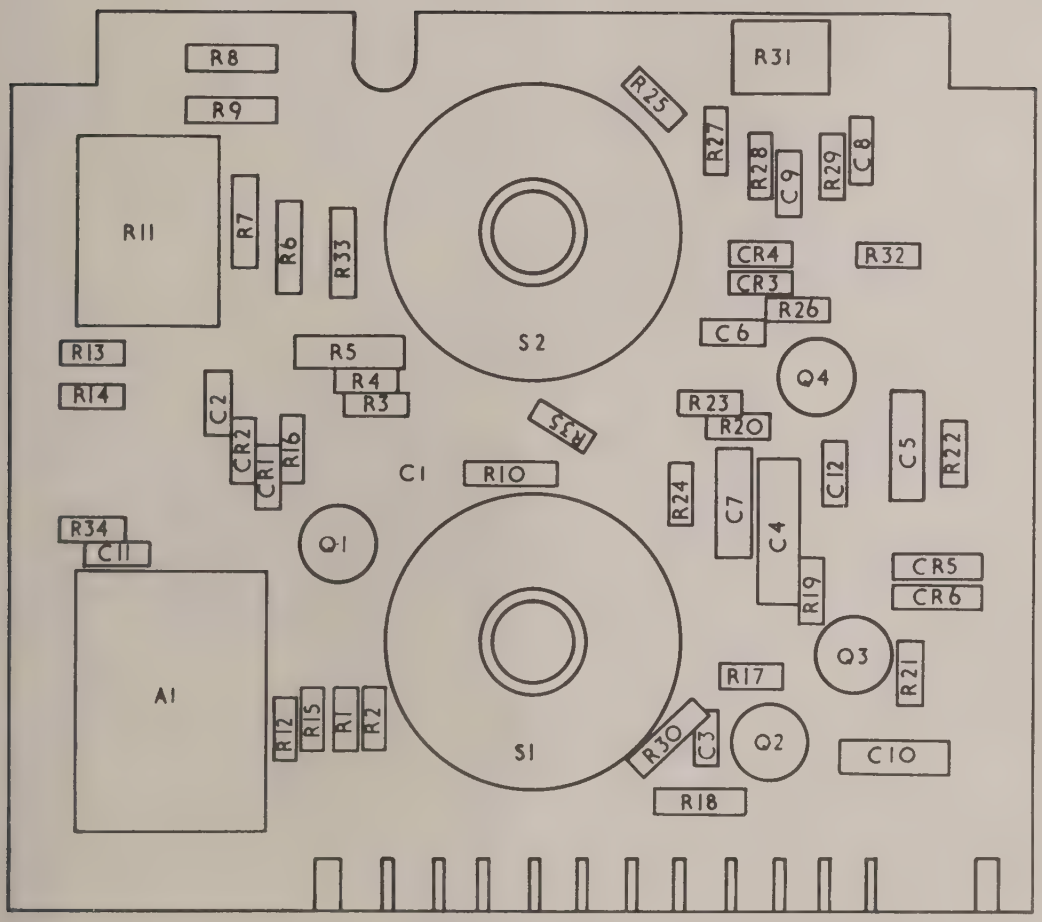
COMPARATOR Y9035



Y9027 DECADE

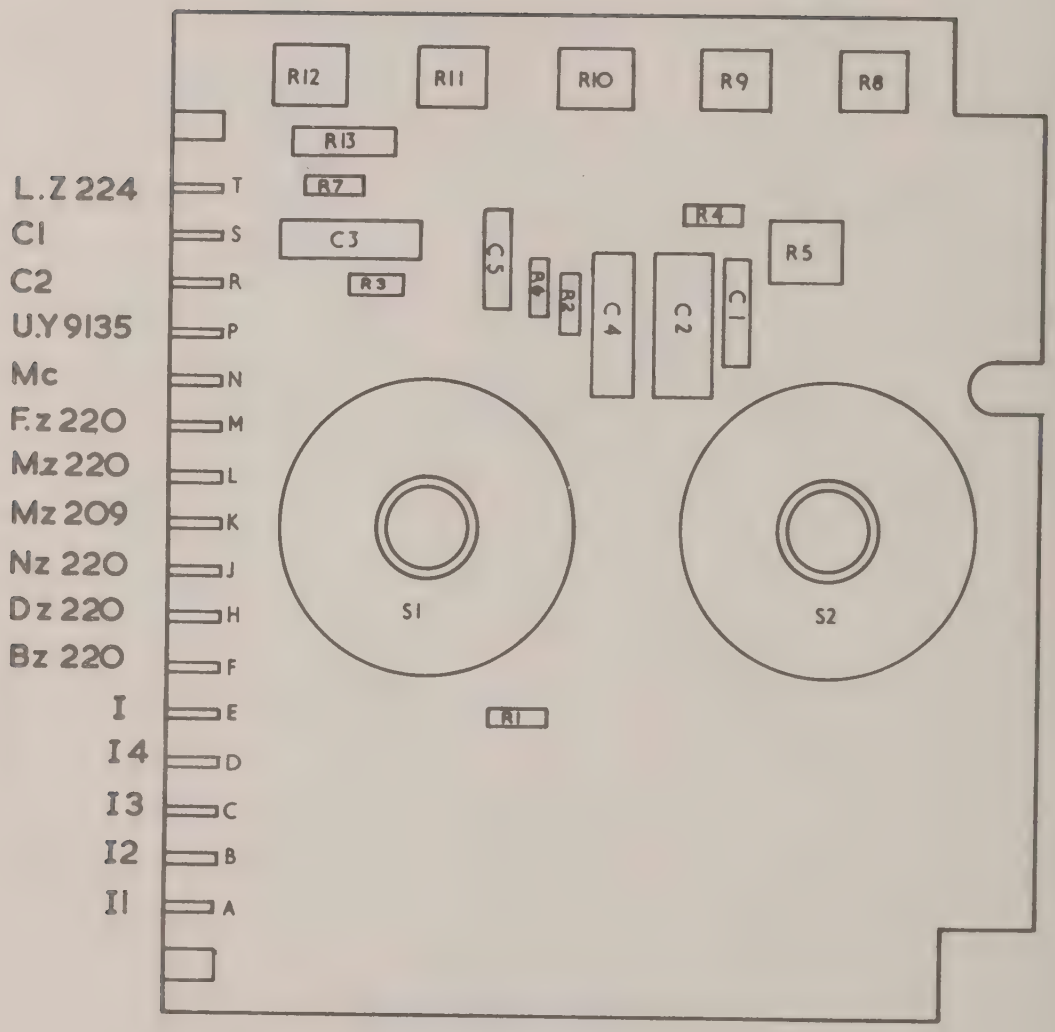


DC/AC ATTENUATOR Z209

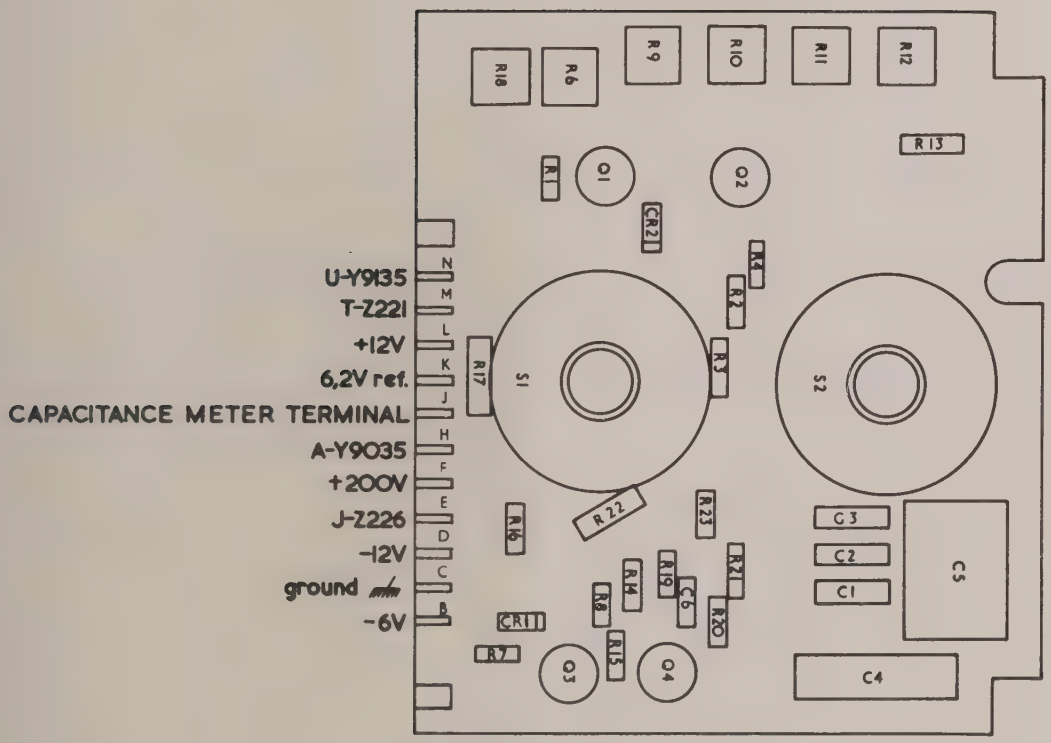


M2 I N
C'/Z263 M
+ 12 L
E'/Z263 K
F'/Z263 J
12V H
M/Z221 F
L/Z209E
H/Z221 D
+ 6V C
F/Z221 B

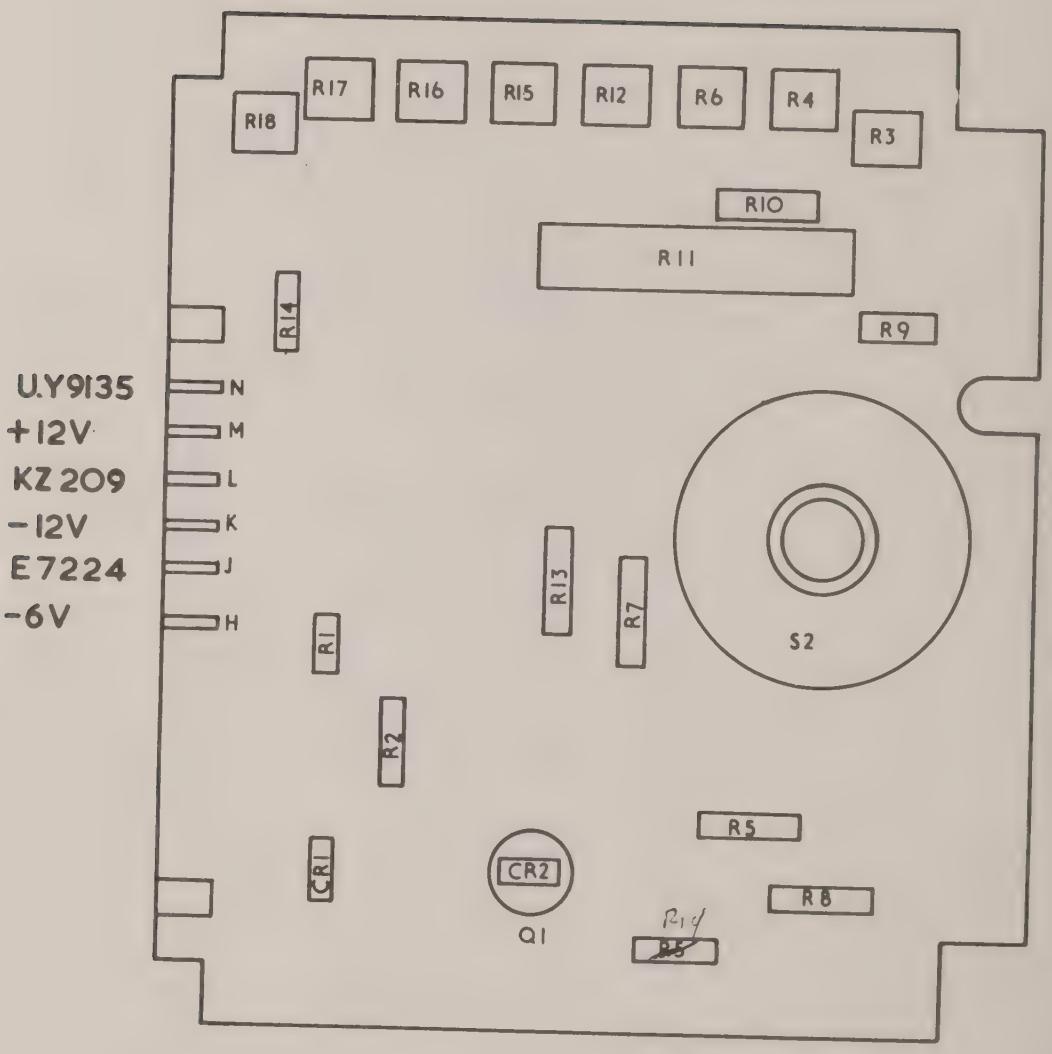
DC/AC AMPLIFIER Z220



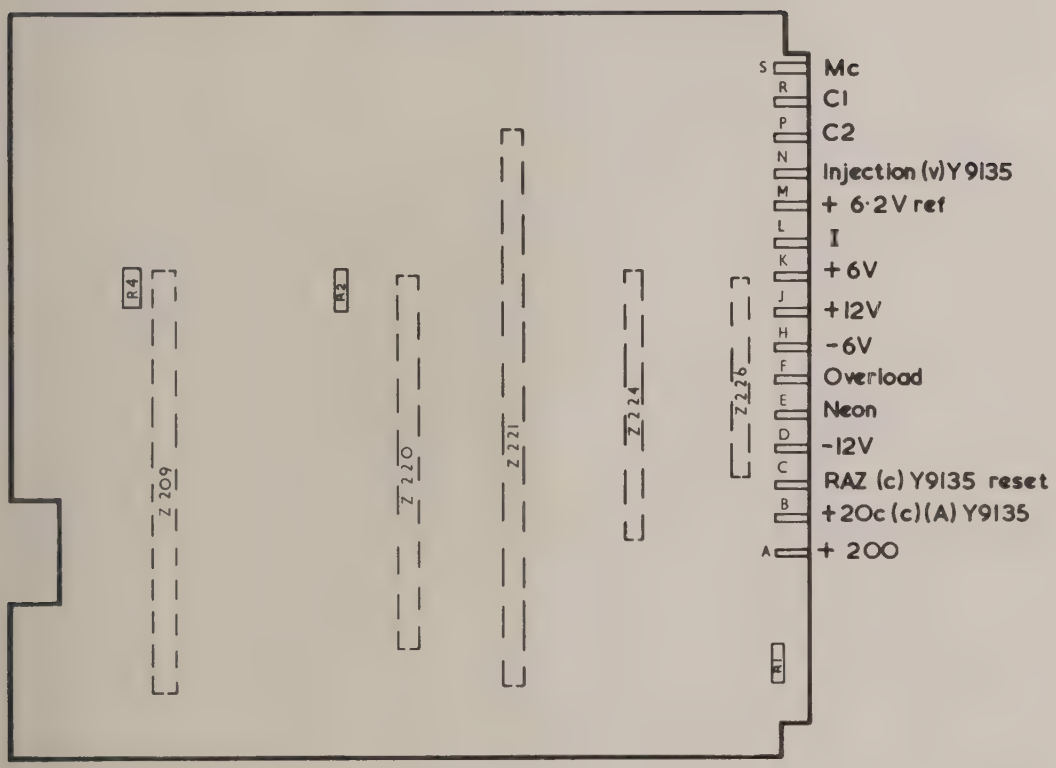
50Hz FILTER Z221



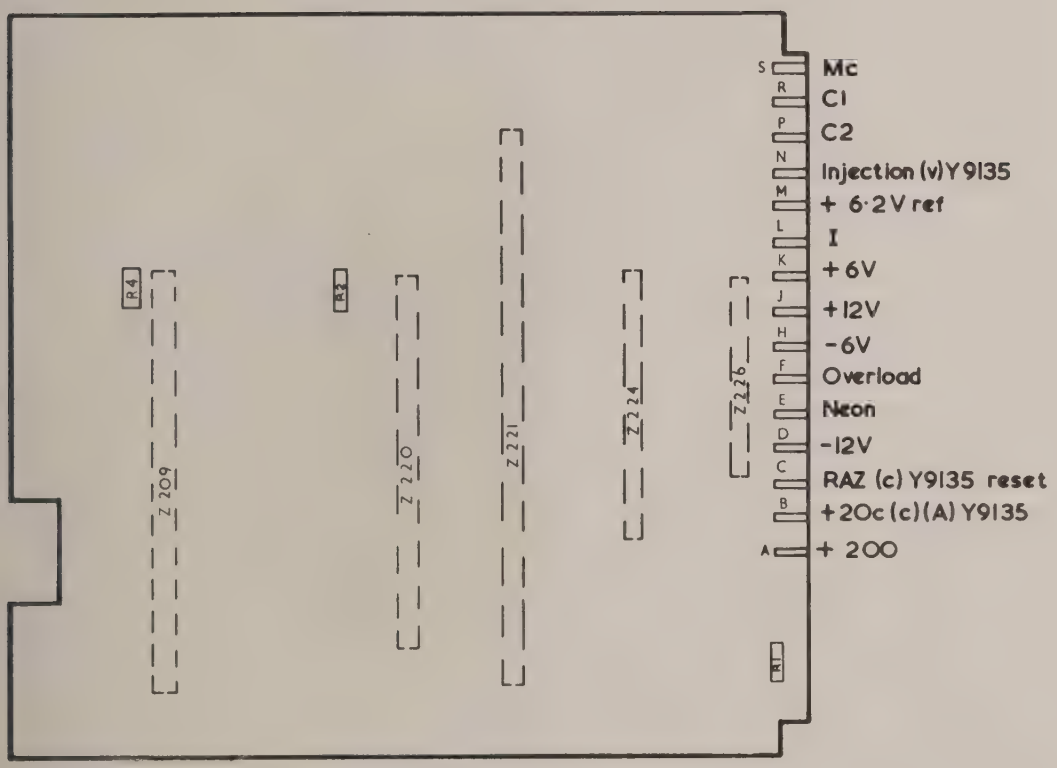
CAPACITANCE METER CIRCUIT Z224



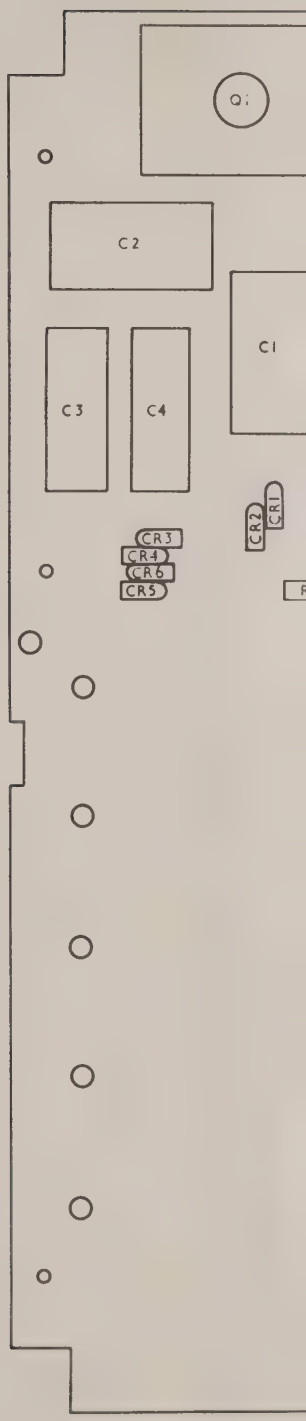
OHMMETER CIRCUIT Z226

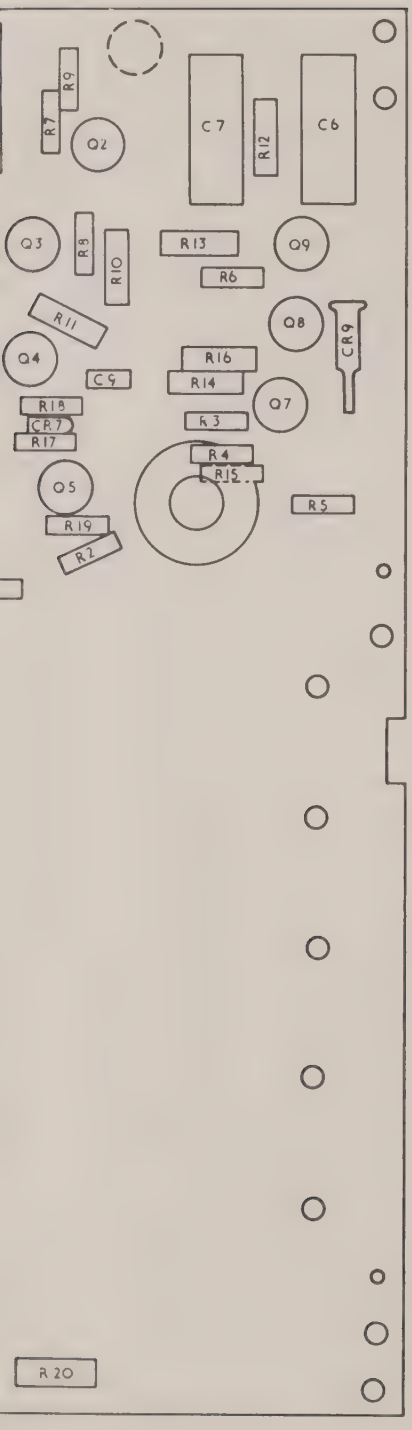


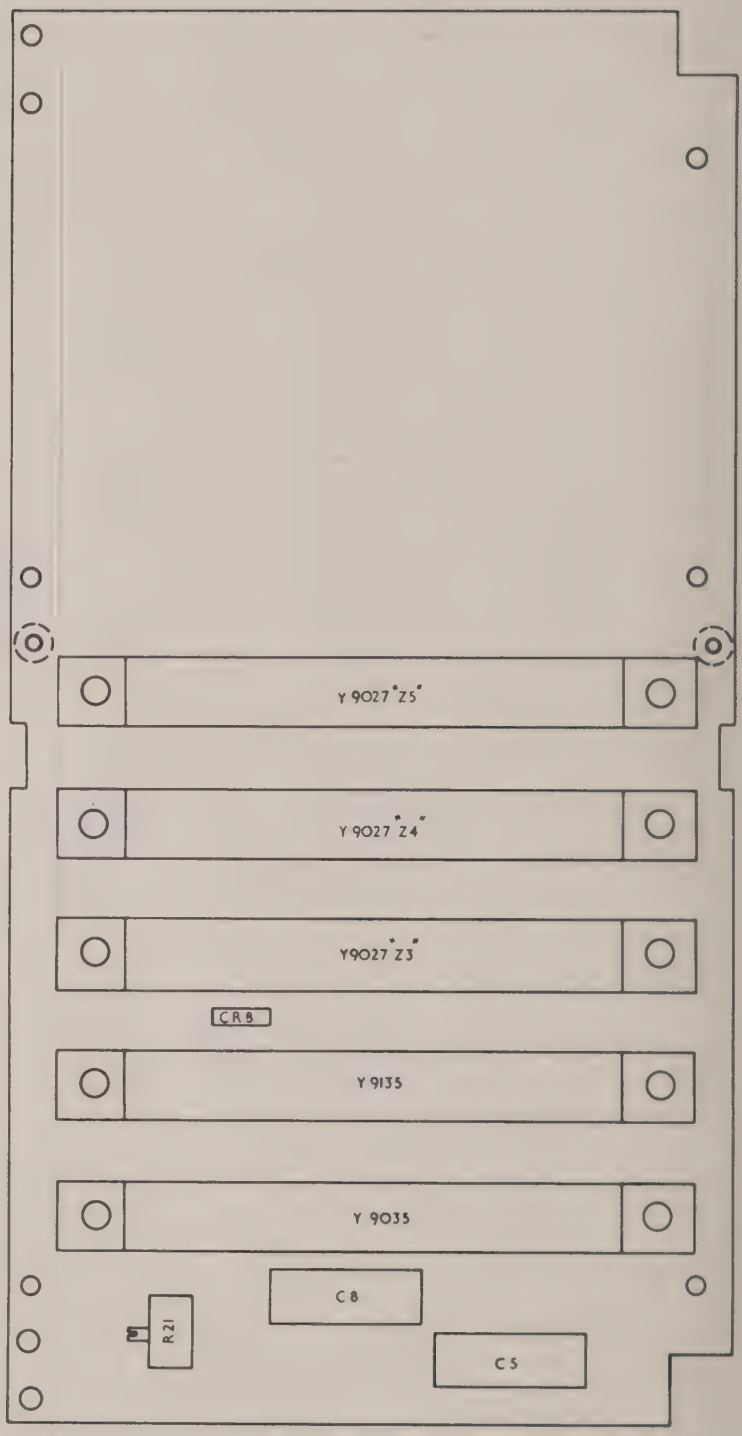
SWITCHING UNIT Z263



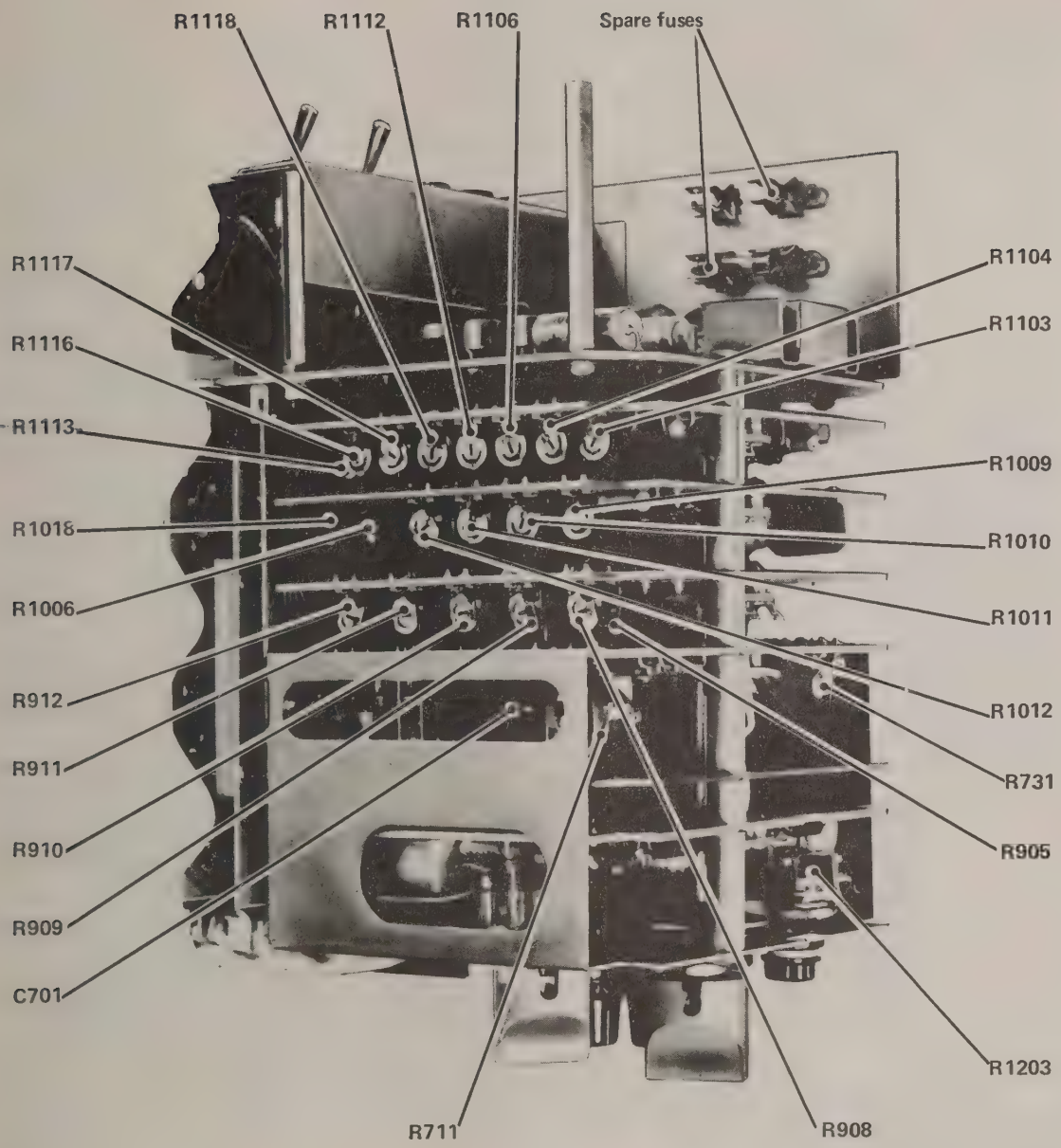
SWITCHING UNIT Z263


Q1
C2
C1
C3
C4
CR2
CR1
CR3
CR4
CR6
CR5



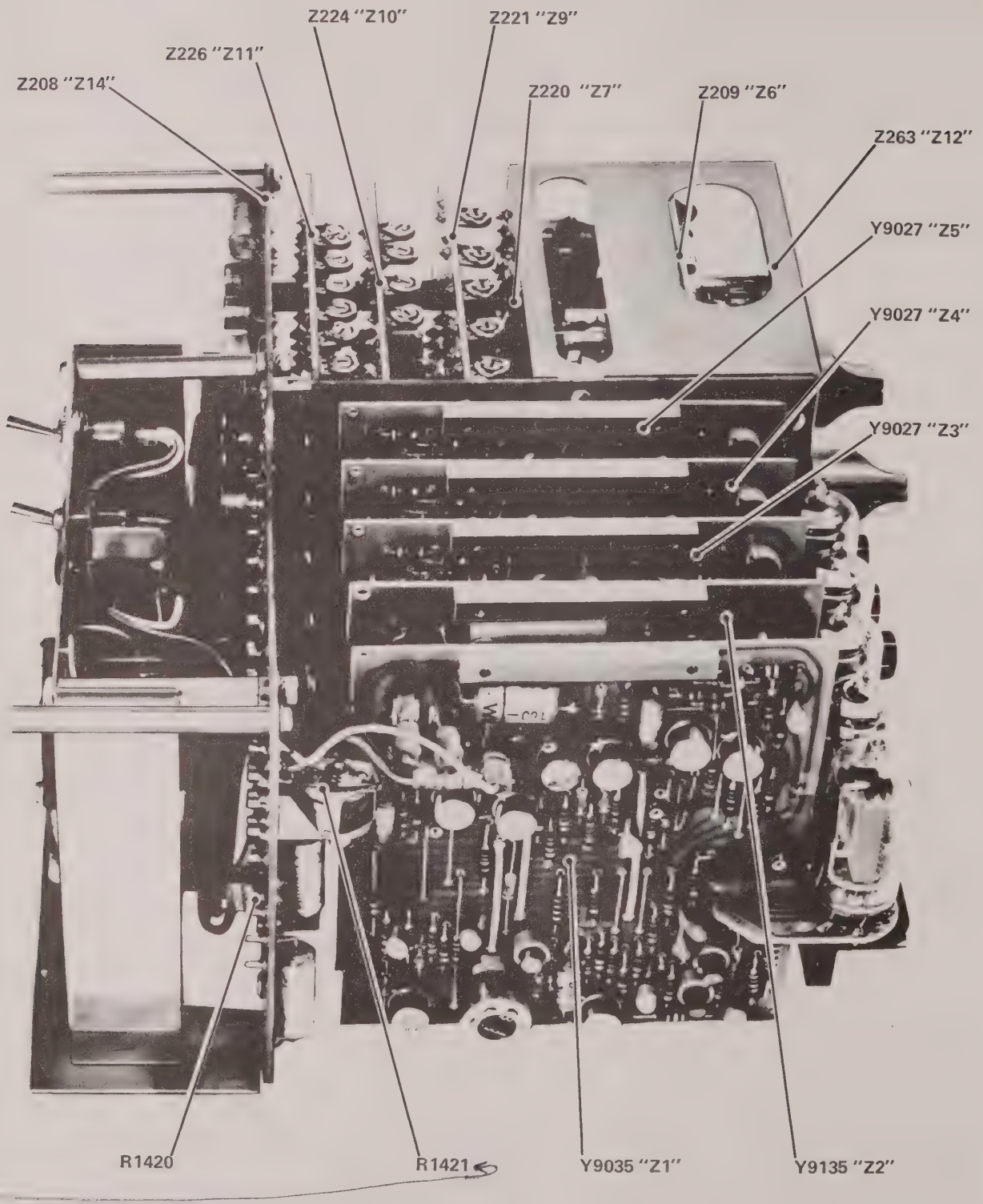


POWER SUPPLY AND DISPLAY Z208



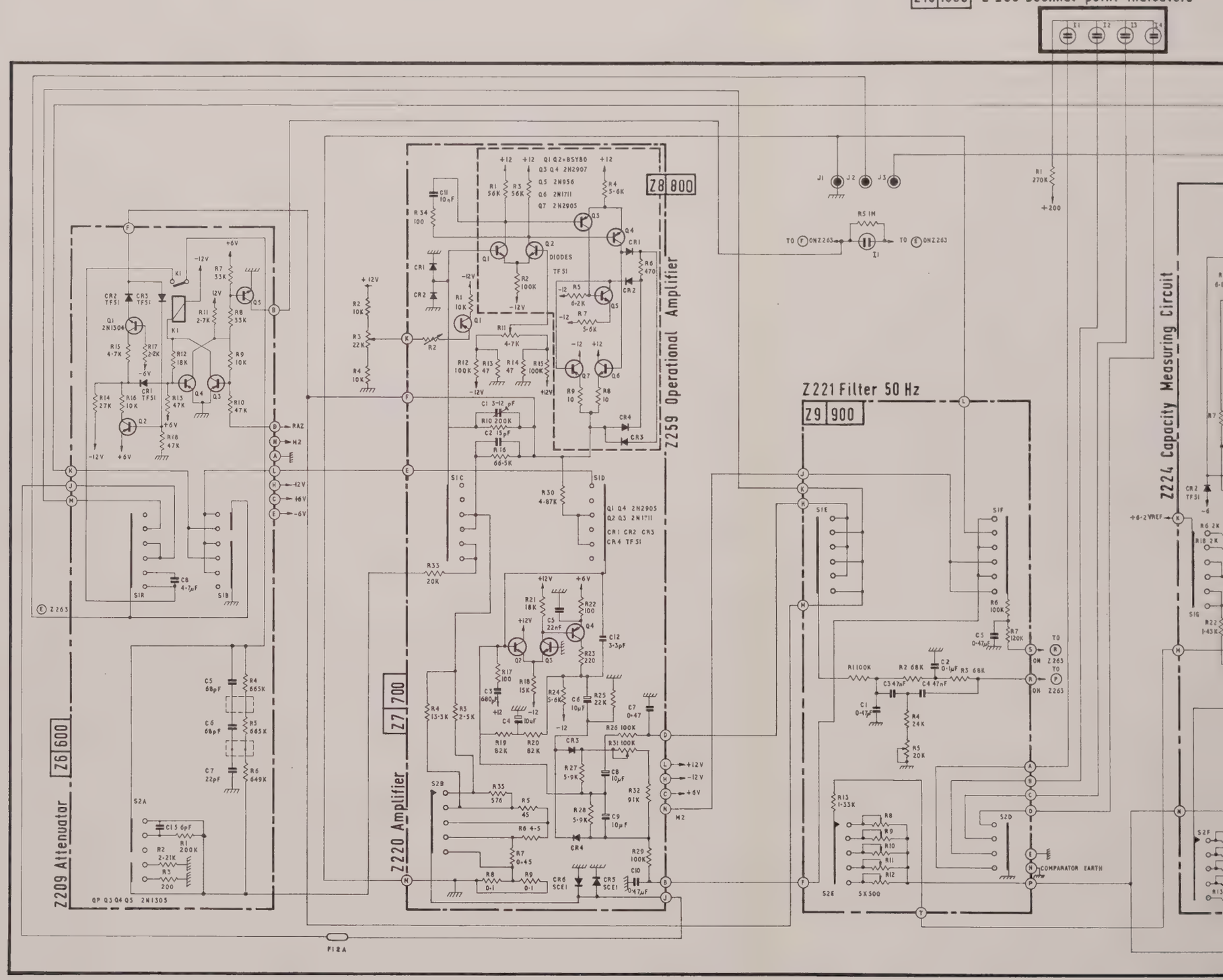
CALIBRATION POINTS

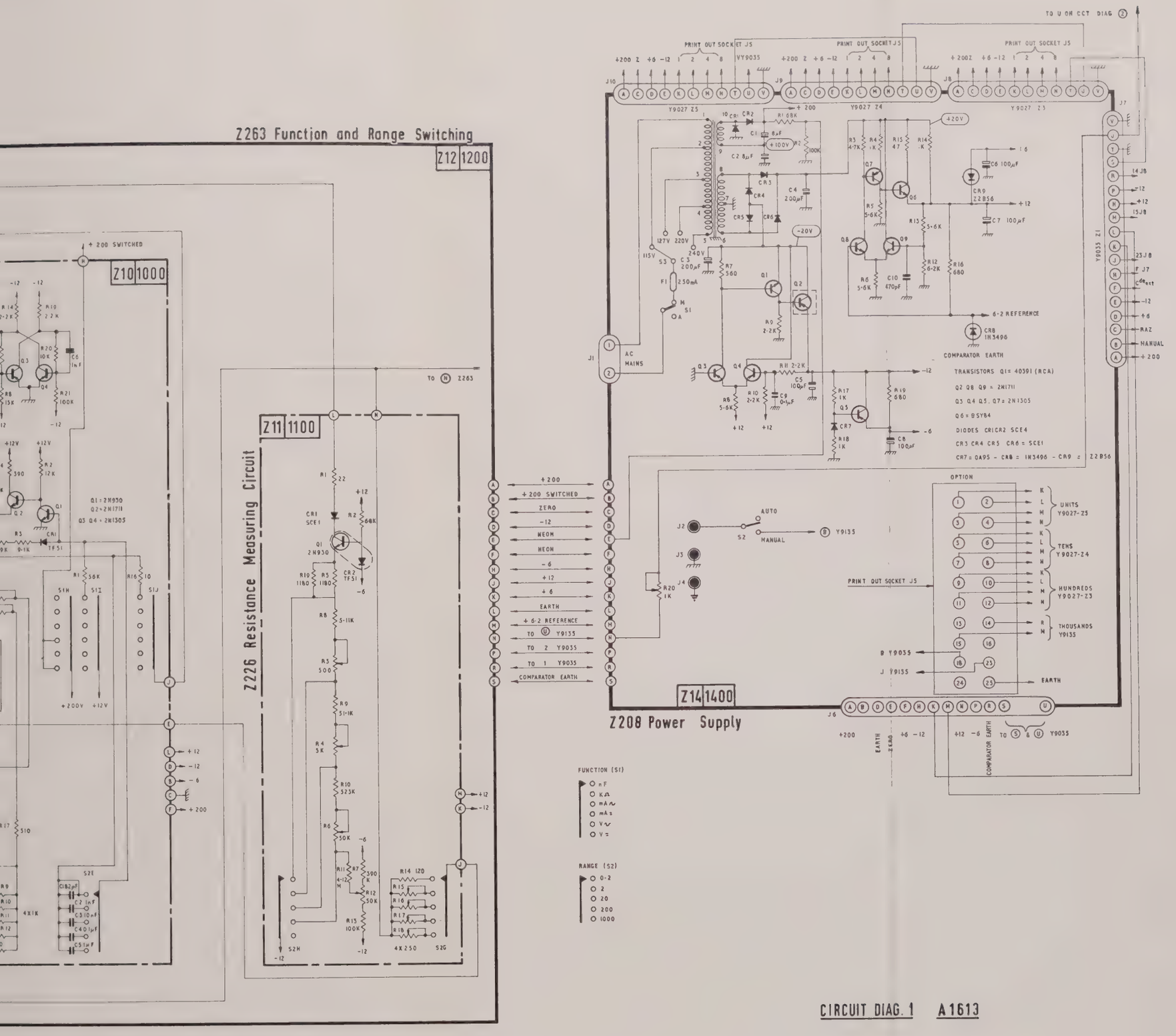
P.T.O. for R1421



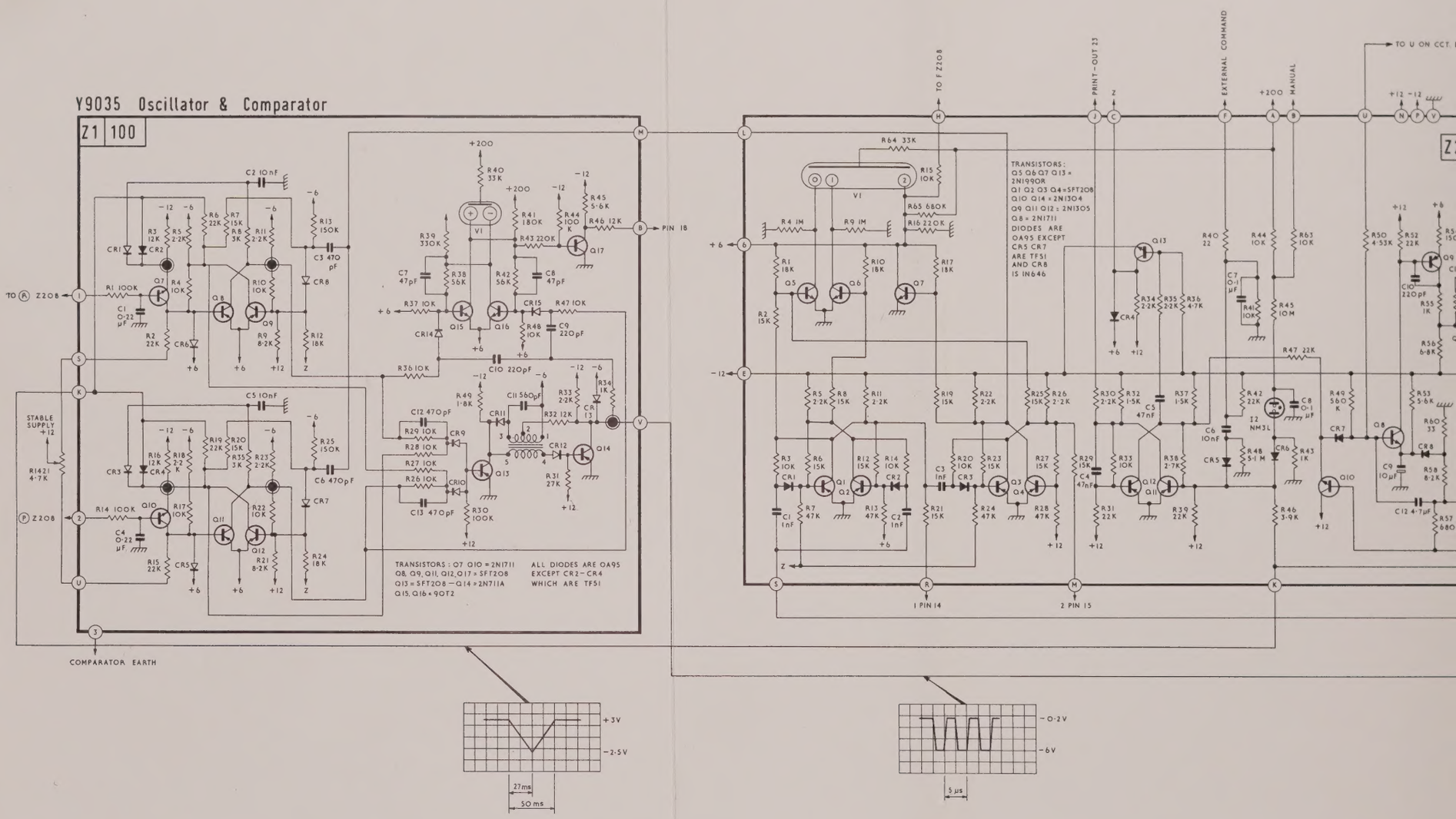
SUB-UNIT LAYOUT

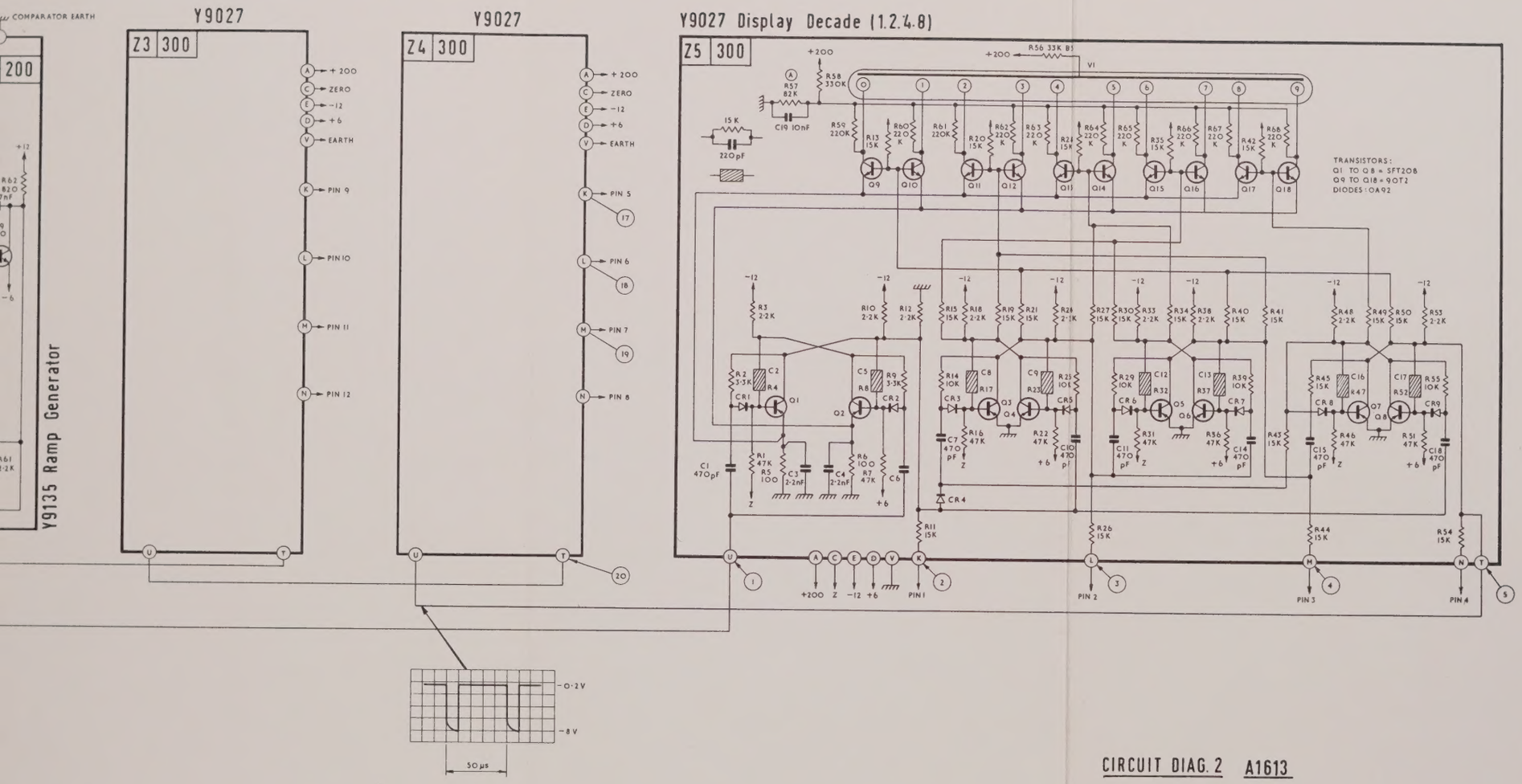
Z13 1300 Z 268 Decimal point indicators





CIRCUIT DIAG. 1 A1613


Y9035 Oscillator & Comparator
Z1 100
TO F Z208
PRINT-OUT 23
EXTERNAL COMMAND
MANUAL
TO U ON CCT.
TO A Z208
P Z208
STABLE SUPPLY +12
PIN 18
COMPARATOR EARTH
1 PIN 14
2 PIN 15
TRANSISTORS: Q5 Q6 Q7 Q13 = 2N1990R Q1 Q2 Q3 Q4 = SFT208 Q10 Q14 = 2N1304 Q9 Q11 Q12 = 2N1305 Q8 = 2N1711 DIODES ARE OA95 EXCEPT CR5 CR7 ARE TF51 AND CR8 IS IN646
TRANSISTORS: Q7 Q10 = 2N1711 Q8, Q9, Q11, Q12, Q17 = SFT208 Q13 = SFT208 — Q14 = 2N711A Q15, Q16 = 90T2
ALL DIODES ARE OA95 EXCEPT CR2 — CR4 WHICH ARE TF51
+3V
−2·5V
27ms
50 ms
−0·2V
−6V
5 µs



CIRCUIT DIAG. 2 A1613

MP MASTER
24232

SEG

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